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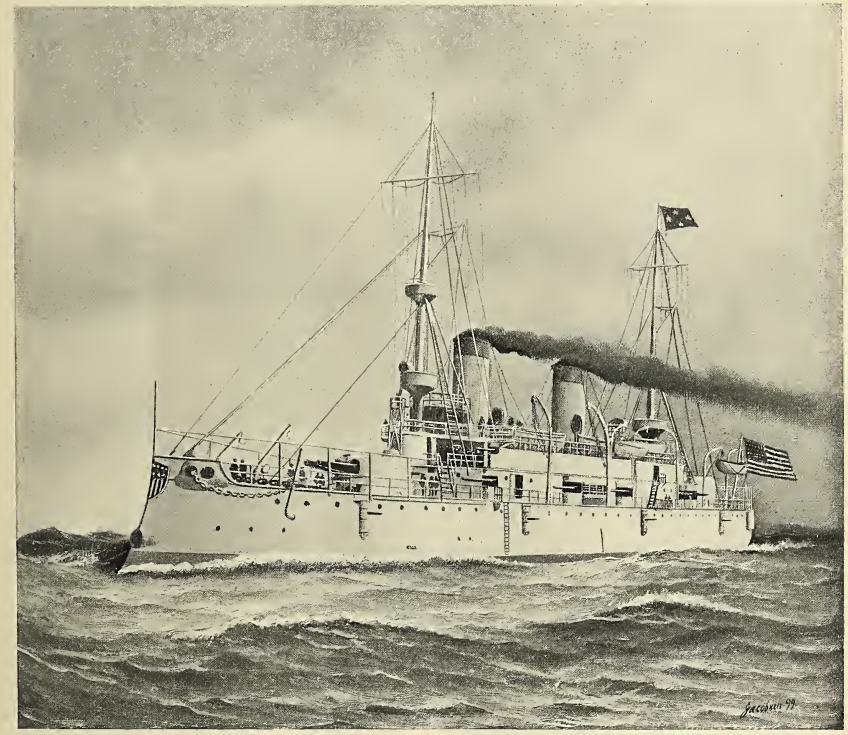
HOME COMING OF THE FLAGSHIP OLYMPIA WITH ADMIRAL DEWEY.

About the time of publication of this issue New York will be ablaze with illuminations by night and gay with decorations by day welcoming home Admiral George Dewey, U. S. N. A tremendous welcome has been prepared by the American people at the first home port which the modest victor of the Manila sea fight will arrive at. There will be a naval review and a large parade, besides banquets and other indoor festivities for the officers and men of the flagship *Olympia* Our artist has made an exact sketch of the home-coming vessel which we here present. In our last issue we gave details of the construction and equipment of the vessel which is a twin screw protected cruiser of about 6,000 tons displacement. The homeward voyage of the *Olympia* was commenced September 11, from Gibraltar, where Admiral Dewey and his men were given a very hearty reception by the British land and naval forces. The *Olympia* is a product of the Union Iron Works, San Francisco.



U. S. PROTECTED CRUISER OLYMPIA ON HER WAY HOME FROM MANILA WITH ADMIRAL DEWEY.

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CONSIDERATION OF THE STEAM YACHT FROM THE DESIGNER'S POINT OF VIEW.—I.

BY WILLIAM A. FAIRBURN.

For the past twenty years steam pleasure craft have been gradually ascending the scale of popularity. Year by year ardent yachtsmen have been abandoning their sailing vessels for larger and costlier steam yachts. There are very few moneyed men to-day who are such enthusiastic yachtsmen that they prefer the sailing yacht, although for genuine yachting sport it must be confessed that the latter will probably always have supremacy. The steam yacht is to-day a very popular vessel. Not only do seafaring men take an interest in her, but landsmen are at once attracted by her rakish, graceful and handsome appearance. The possession of a steam yacht denotes the wealth of the owner, and partly for this reason steam yachts are very popular with moneyed men. In these days the size of a gentleman's steam yacht is generally proportional to his bank account, and quite a large number of millionaires at present seem to vie with each other in the ownership of magnificent, luxurious and speedy floating palaces.

Although the term steam yacht signifies a pleasure craft propelled by steam, yet the term as popularly used refers to steam pleasure craft larger than the cockpit or open launch. While no hard and fast rule as to size can be laid down, it may be stated that, generally, the "launch" is less than 55 or 60 ft. long and the "yacht" is a longer vessel. The launch is generally open to the weather, while the yacht has inclosed accommodation. Usually the launch has a perpendicular bow, while the yacht almost invariably has a long, tapering, overhanging, clipper stem. Ignoring for the present the launch type of "steam yacht," we may say that the modern steam yachts can be divided into five classes: I—Full powered seagoing steam yachts. II—Seagoing steam yachts with sail auxiliary. III.—Seagoing sail yachts with steam auxiliary. IV—Coastwise steam yachts. V—Coastwise auxiliary steam yachts.

Until the past few years there were very few vessels of Class I afloat, but, as before mentioned, of late years a great rivalry among moneyed men for the possession of the finest, largest and speediest steam yacht afloat seems to have sprung up, the result being that year by year larger and faster seagoing full powered steam yachts are being constructed. Some of the most modern vessels are veritable ocean liners, and they represent the most modern and most approved methods of marine construction. The *Valiant*, owned by W. K. Vanderbilt and built by Laird Bros., of Birkenhead, England, from designs by St. Clare Byrne of Liverpool, is the largest full powered seagoing steam yacht afloat—excluding a few vessels (mostly of the cruiser type) owned by the crowned heads of Europe. The *Valiant* was built in 1893, her length between perps. being 310 ft.; beam, 39.3 ft.; depth, 25.6 ft.; tonnage, about 2,400 tons. She is a twin screw vessel of about 5,000 I. H. P. and 17 knots speed. The *Mayflower* and *Nahma*, with tonnage of 1,780 tons and waterline length of 275 ft., were built at Clydebank, Scotland, in 1896-7 for Ogden and G. Robert Goelet, of New York, respectively, from designs by Gen. L. Watson, of Glasgow. The sudden death of Ogden Goelet was the cause of the *Mayflower* being offered for sale. The U. S. Navy Dept. early in March, 1898, purchased her for about $400,000, converting her into a despatch and special service vessel. These boats are very fine, powerful twin screw vessels of 4.600 I. H. P. and 16.75 knots speed. The *Varuna*, of 260 ft. waterline length and 16.75 knots speed, was built by A. &. J. Inglis, of Glasgow, Scotland, for Eugene Higgins, of New York, from designs by G. L. Watson, in 1896. She is a smaller *Mayflower*, and is of about 1,500 tons measurement. The *Margarita II*, of 239 ft. w. l.; 3,400 I. H. P.; 16 1-2 knots speed, was built at Troon, Scotland, about the same time, for A. J. Drexel, of Philadelphia, from the plans of the same designer. The *Margarita II*, is a handsome vessel, but Mr. Drexel, finding that she was smaller than he desired, placed the order for a large, palatial steam yacht of about 1,800 tons with G. L. Watson & Co., Glasgow, a few months ago. This vessel is now being built by the Scotts, of Greenock, Scotland. She is 272 ft. long and 36 ft. 6 in. beam, and is of special interest owing to the fact that she will be the first yacht owned by an American under the recently enacted law, which requires him to pay entrance and clearance fees at every port in the United States which his yacht visits, the same as any foreign merchant vessel owner. A year ago Scott & Co., Greenock, Scotland, completed a magnificent vessel of this type named the *Aegusa* for Commendatore Ignazio Flori, of Italy. She has a w. l. length exceeding 250 ft.; beam, 31 ft. 6 in.; depth, 20 ft. 6 in., and is 1,243 tons register. A single screw with triple expansion engines of 2,500 I. H. P. gave the vessel a trial speed of 16 1-2 knots. This vessel has quite recently been purchased by Sir Thomas Lipton, the British challenger for the America's Cup, and rechristened the *Erin*.

The finest specimen of a full powered steam yacht afloat was the *Giralda*, but she is now a despatch vessel, having been purchased by the Spanish Government just previous to the commencement of the Hispano-American war. She does not excel in appearance any of the yachts before mentioned, but power, strength and seaworthiness are her striking characteristics. "Did you ever see such an enormous smoke-stack in your life?" was the first remark generally made by yachtsmen when inspecting her.* She certainly has an enormous stack, and the grace of the hull which it overtops somehow seems to intensify its appearance of bulk. Below deck, one-half the vessel's length is occupied by machinery, although the athwartship bunkers are very small indeed. She is a twin screw vessel with vertical triple expansion engines, which on trial developed 8,500 I. H. P. at 220 revolutions, giving the vessel the remarkable rate of speed of 20.9 knots. Steam is supplied by three double and two single ended Scotch boilers at 170 lbs. pressure, working with closed stokeholds. The *Giralda* combined the principal features of a pleasure craft and a cruiser, and when commanded by her original owner, Harry McCalmont, it is said that sixty members of the British Naval Reserve composed the vessel's complement. She is 275 ft. long on the water, 312 ft. over all, 35.2 ft. beam, 19 ft.

* In the case of yachts the size of the stack is often no indication of the power of the vessel. Funnels of excessive outside dimensions are not unusual, to give an "appearance" of power.—ED. M. E.

deep and 1,508 tons register. The *Giralda* was built and designed by the Fairfield Co. of Glasgow, in 1894. This company is also well known as the builder of Baron Edmund De Rothschild's yacht *Atmah* (built eighteen months ago) which was recently sold. She is 280 ft. long on the water line, 34 ft. beam, and has a speed of 15.75 knots.

One of the most graceful, handsome and successful full powered steam yachts afloat to-day, and one that has been greatly admired by all yachtsmen who have been fortunate enough to inspect her, is the Watson designed yacht *Rona*. She was built by D. & W. Henderson, of Glasgow, for Arthur H. E. Wood, of England, in 1895. She has a light brigantine rig and is 243.7 ft. long, 30 ft. beam, 18.25 ft. depth of hold, the loaded draft being 16 ft. and tonnage 1,053 tons. On trial she averaged 15 knots speed on a 27 knot course. The latest American built full powered seagoing steam yachts are the 300 ft. over all *Corsair*, contracted for by the W. & A. Fletcher Co., of Hoboken, N. J., for J. Pierpont Morgan, and P. A. B. Widener's new *Josephine*, recently completed by Neafie & Levy, of Philadelphia. The latter vessel is very roomy and very high-sided for her length. Her designed speed is 17 knots.

It would be uninteresting to enumerate more vessels of this type, as quite a number of full powered steam yachts with waterline lengths varying from 200 to 250 ft. have been built during the past few years. James Gordon Bennett, of the New York "Herald," a few months ago commissioned Mr. Watson to design a palatial twin screw steam yacht, which, while having all the characteristics of such craft (fineness of form and luxuriousness of living accommodation), should be able to carry sufficient coal to enable her to cross the Atlantic at a much higher speed than has hitherto been thought possible in such craft without in some way recoaling. At present the record in this matter is, if the writer is not mistaken, held by the *Varuna*, which, nearly two years ago, accomplished this voyage at an average speed of 13 1-2 knots. Mr. Bennett's new yacht is now being constructed by W. Denny & Bros., of Dunbarton, Scotland. Mr. Bennett's present yacht is the *Namouna*, built in 1881 at Newburgh, New York. She is still a fine vessel of 616 tons and 216 ft. w. l. length.

In Class II—seagoing steam yachts with sail auxiliary—we find that these vessels have a speed under steam alone of about 12 to 14 knots, and usually they are fitted with about 2-3 full sail power. The finest and most successful vessel of this type afloat is probably the barque-rigged single screw yacht *Eleanor*, designed and built by the Bath Iron Works, Bath, Me., C. R. Hanscom, general superintendent, for William A. Slater, of Norwich, Conn., in 1893. This vessel has circumnavigated the globe and steamed over 100,000 miles without an accident and with hardly a dollar being spent in repairs. There are very few finer looking vessels than the *Eleanor* afloat to-day, for, although her stern is much too heavy for appearances, it must be remembered that she was designed seven years ago primarily for a deep sea cruiser, and her form and arrangement for service and utility have been greatly admired by seafaring men. The *Eleanor* is 208 ft. on the water line, 32 ft. beam, and has a speed of 13 1-2 knots under steam alone. Her average speed under steam across the Atlantic on one occasion was 12 1-2 knots, and using both sail and steam she has logged 14 1-2 knots for days. One of the latest American built steam yachts which might be considered as belonging to this type of pleasure craft is Archibald Watt's twin screw steam yacht *American*. She is ship rigged, a freak in many respects, but certainly no yacht in appearance or proportions. The *American* is the result of a millionaire's whim. The owner, having considerable money, decided to build a yacht from his own design, and he chose to do this rather than to consult expert designers and experienced shipbuilders. The *Niagara*, a twin screw yacht recently completed at the yard of Harlan & Hollingsworth, Wilmington, Del., for Howard Gould, is another modern vessel of this type. She is also barque rigged and has a water line length of 245 ft.; length over all 270 ft.; beam 36 ft., and a speed of about 14 knots. Few vessels of this type have been built, for most yachtsmen seem to prefer speed. A large sail spread with a favorable breeze does very little to increase a vessel's speed, while the spars, sails, and rigging add considerably to the resistance of the vessel, especially at high speeds with a head wind. Therefore the tendency of late years has been to put into these vessels more engine power and reduce the said spread. Almost all full powered steam yachts have more or less canvas, but it is usually carried to give steadiness and comfort in a seaway, and not to be used in propulsion. The *Valiant* is brig-rigged, but with a fair wind her speed is only increased a small fraction of a knot by the use of her canvas.

Vessels of Class III—sail with steam auxiliary—are usually rather small. There is, however, one large modern vessel of this type afloat, the *Valhalla*, owned by Joseph F. Saycock of the Royal Yacht Squadron, England. She is the largest vessel of her kind in the world and she has attracted a good deal of attention from yachtsmen on account of her large size, full ship rigging, and handsome appointments. The *Valhalla* depends almost entirely on her sails as a means of propulsion, and her steam equipment is for use only in case she becomes becalmed. She was built in 1892, and is 239.6 ft. long over all, 37.2 ft. beam, 20.7 ft. deep. Her mainmast is 141 ft. long and her mizzen mast 125 ft. long. She presents a very shipshape appearance, but yet one cannot say that she looks yachty. Perhaps no vessel of this type has become better known throughout the world than the old composite auxiliary steam yacht *Sunbeam*, designed by St. Clare Byrne for Mr. (now Lord) Brassey, and built by Bowdler, Chaffers & Co. of Seacombe, England, in 1874. She is 180 ft. long over all, 27 ft. 6 in. beam and 13 ft. 6 in. draught. On trial her compound engines developed 380 I. H. P., which gave the vessel a speed of 10 1-4 knots. She is fitted with a Bèvis's patent feathering propeller, as is usual with vessels of this type. She has a fore and aft rig, her longest mast, deck to cap, measuring 80 ft., and her total sail area is about 12,000 sq. ft. She is ballasted with lead between the floors. In the famous voyage of the *Sunbeam*, so pleasantly told by the late Lady Brassey in her published work, this successful vessel circumnavigated the globe, accomplishing in her cruise 35,450 miles, of which 20,400 were under canvas

alone. The *Sunbeam's* best day's sailing was 299 miles, and her best day's steaming was 230 miles. The British auxiliary steam yacht *Lancashire Witch*, entirely under canvas, made the distance 4,458 miles, from the Falkland Islands to Natal, in 23 days. Her best day's sailing was on a voyage to Yokohama, when she covered 295 miles in 24 hours. Her best day's steaming was 216 miles. The advantage of an auxiliary steam vessel may be therefore very considerable in extended voyages where the trade winds can be made use of, and even in head winds if she is a fairly weatherly vessel. The *Arcturus*, designed by St. Clare Byrne for Rutherford Stuyvesant of New York and built by Ramage and Ferguson, Leith, Scotland, in 1896, is a fine modern vessel of this auxiliary type. She is schooner-rigged; 169 ft. over all; 135 ft. on the water; 27 ft. beam, and 13 ft. draught. She is fitted with an engine of 500 I. H. P. and two Almy water tube boilers, and on the measured mile she attained a speed of 11.75 knots. The *Lady Torfrida*, *Intrepid*, *Utowanga* and *Sultana* are fine vessels of this type, and the American wooden yacht *Sagamore* is yearly adding to her laurels as a highly successful auxiliary barkentine-rigged steam yacht. Some yachtsmen have proclaimed Lord Phoenix's yacht *Intrepid* to be the finest auxiliary cruiser afloat. The majority of these vessels have a fore and aft rig and the height of the spars increase as they go aft. This feature certainly does not improve their appearance. Many vessels of this type are somewhat tender, the hulls lacking power and the vessels being over-canvased.

Class IV—coastwise steam yachts—contains hundreds of smaller steam yachts ranging up to 150 ft. waterline or even longer. Many long steam yachts would have to be classed under this heading owing to their proportions and very limited endurance. It is impossible, however, to draw the line between the coastwise and the ocean-going steam yacht, for many a vessel that is seldom out of sight of the American shore is quite capable of making an extended ocean voyage. The smallest steam yacht, excluding the sloop *Alice* and J. G. Cassatt's old yacht *Eugenia*, to cross the Atlantic, is the *Sylvia*, owned by E. Y. Brown of New York. She was built by A. Stephen & Sons of Glasgow in 1882, and is 130 ft. long on the water, 18 ft. 6 in. beam and 10 ft. 10 in. draught. This yacht left Queenstown December 20, 1894, with forty tons of coal on board. The run to Funchal, Madeira, was made in 5 days 12 hours, and after coaling the *Sylvia* proceeded on her journey to Bermuda, which was reached January 10. One day was spent in coaling, and on January 15 Sandy Hook was sighted. The average revolutions for the voyage were 93; the coal consumption per day was 4 1-2 tons, and the distance covered, Queenstown to New York, was 4,636 miles, the time occupied being 20 days 22 hours. It appears, therefore, that a 139 ft. steam yacht of British proportions is capable of crossing the Atlantic, and is therefore considered a seaworthy vessel. It must be remembered, though, that the commander, Captain Arthur H. Clark, went through experiences which few men would care to undergo. The officers and crew deserted the ship at Waterford, Ireland, refusing to make the voyage in so small and unseaworthy a little vessel. On account of her small endurance it will be seen that the vessel had to steam over 4,600 miles instead of 2,800 miles—the direct course.

The *Sylvia* is a typical British coasting steam yacht, for although somewhat old her characteristics are about the same. The *Neckan*, *Free Lance*, *Illawarra*, *Aileen*, *Embla*, *Idalia*, *Formosa*, *Eugenia* and *Peregrine* can be looked upon as representative American built steam yachts of this type. But these vessels have no similarity. Each designer has his own peculiar ideas. There are no national characteristics, as is the case of the British smaller yachts, and one can only describe them as something different from the British boats.

The *Iluna* and *Hermoine*, British steam yachts now owned by Americans, are representative vessels of the British medium size coasting type. Of the larger type, which border on Class I—full powered sea-going yachts—the *Conqueror*, *Narada*, *Andria* and *Sapphire* are representative vessels of British design, while the *Columbia*, *Nourmahal*, *Alberta*, *Sovereign*, *Kanawha* and the old *Corsair* and *Josephine* represent the work of American designers. It will be remembered, however, that a few of these yachts were purchased during the late war by the U. S. Navy Department, and therefore they can be classed as steam yachts no longer.

Class V—coastwise auxiliary steam yachts can almost be ignored, as the vessels of this type must necessarily be small. An auxiliary yacht to be successful must have proportions which tend to give her great sea-keeping capabilities, and therefore auxiliary steam yachts as small as 80 ft. waterline length may be classed as ocean-going. The American built auxiliary yacht *Wild Duck* of 125 ft. waterline, and 23 ft. 3 in. beam, is quite famous, as is also the British-built *Satanella*, late *Golden Fleece*, of 113 ft. 6 in. waterline and 22 ft. 6 in. beam. These boats, although but a little over 100 tons burden, have made extensive ocean cruises. The British auxiliary screw schooner *Water Lily*, built by Day, Summers & Co. of Southampton is another representative vessel of this smaller auxiliary type. She is 119.8 ft. long and 23.4 ft. beam, and is now owned by George F. Muntz.

White Star Liner Oceanic.—The maiden trip of the White Star Liner *Oceanic*, which begun at Liverpool September 6, was completed at New York September 13. The time from Daunt's Rock to Sandy Hook light was 6 days, 2 hours and 37 minutes. The best day's average was on the fourth day out, when the vessel maintained a speed of 20 1-2 knots. The daily runs were: 443, 470, 457, 496, 483 and 431 knots. The ship behaved splendidly on the trip, being exceedingly steady, and the machinery worked perfectly. The engineers' department labored under the disadvantage of having a green crew aboard, owing to a strike which prevented the shipment of an experienced crew of stokers at Liverpool. Among the passengers was the Right Honorable W. J. Pirre, of the firm of Harland & Wolff, the builders. It is understood that on the next voyage an attempt will be made to lower her time, although the expectation of the builders and owners is that she will not be a flier, but will be able to make her trips with train time punctuality.

The new transatlantic liner *Lorraine* for the Havre-New York service of the Compagnie Generale Transatlantique (French Line) was launched recently at St. Nazaire, France. The new vessel is 580 ft. long, and it is understood that she will have a sea speed of 22 knots.

INCREASING DIMENSIONS OF FREIGHT STEAMSHIPS IN TRANSATLANTIC TRADE.*

BY G. B. HUNTER.

Since 1891, and more especially since 1894, there has been a great increase in the size of cargo steamers employed in the Atlantic carrying trades. This has been largely due to the foresight and enterprise, first, of Harland & Wolff and the owners of the White Star Line, of Liverpool, and more recently of R. S. Briggs and R. M. Hudson, Sunderland; Sir Christopher Furness, and Elder, Dempster & Co.[1] There is practically no limit to the size of cargoes that can be obtained in America. It is remarkable that until 1895 there were no British cargo steamers of more than 6,500 tons gross register, except the *Bovic,* 6,583 tons gross register, and *Cevic,* 8,301 tons gross register, of the White Star Line, built by Harland & Wolff in 1892 and 1893; the *Samoa,* 6,839 tons gross register, and *Maroa,* 6,802 tons gross register, owned by Crow, Rudolph & Company, Liverpool, and built by W. Doxford & Sons in 1892 and 1894—and always excepting the *Great Eastern.*

Of merchant steamers (both for cargo and passengers), 6,000 tons gross register and over, according to a return of Lloyd's registry, there were building in March, 1895, ten vessels, and in March, 1899, fifty-four. Among the largest cargo, or partly cargo, steamers now building are the *Saxonia* and *Invernia,* of about 13,200 tons gross register, for the Cunard Company, by the Clydebank Shipbuilding Company, Limited, and C. S. Swan & Hunter, Limited, respectively. Of merchant steamers, 10,000 tons gross register and over (cargo and passenger), there are now building in British yards eighteen vessels, including the *Oceanic,* about 17,000 tons; in German yards, nine; and in French shipyards, two vessels.

To illustrate the rapidity with which cargo steamers have been increased in size, and also the increasing adoption of twin screws, the following table from a paper read by E. W. de Russett, M. Inst. C. E., before the Institution of Civil Engineers, with a slight addition, is given (all the more recent steamers were built for the Atlantic trade):

PARTICULARS OF SOME OF THE LARGEST ENGLISH CARGO STEAMERS.

Year.	Name.	Dimensions.			Tonnage.	Water Ballast	Screw.
		Length	Bre'dth.	Depth	Gross.		
		Ft. B. P.	Ft. In	Ft. In	Tons.	Tons.	
1891	Chancellor	400	47 6	31 6	4,753	831	Single.
1892	Tokomaru	425	53 0	34 0	6,237	1,310	"
1894	Aotea	430	49 0	32 10	5,652	1,073	"
1895	Westmeath	450	56 0	34 6	6,850	1,555	"
1896	Milwaukee	470	56 0	34 10	7,317	2,555	"
1897	Monarch	470	56 0	34 10	7,295	2,592	"
1898	Mount Royal	470	56 0	34 10	7,044	3,590	"
1898	Ultonia	500	57 4	37 0	8,056	2,659	Twin.
1899	Saint Andrew	470	56 0	34 0	6,900	3,234	
1899	Invernia (building)	580	64 6	41 6	13,200 about	4,550	"

Instead of singling out an existing steamer for description, some leading features of a typical American freight steamer of the present or early future, for carrying large cargoes across the Atlantic economically and safely, on a moderate draught was discussed. With docks, harbors, and markets, as they are and will be, such a vessel might be designed to carry not less than 12,000 tons deadweight, with cubic capacity for 20,000 tons of cargo at 40 feet per ton, and 1,000 tons of fuel. This would require dimensions approximately as follows: Length between perpendiculars, 500 ft.; breadth, 60 ft.; depth, moulded, 36 ft. to main deck; 44 ft. to shelter deck. The draught of water loaded would be about 27 ft. 6 in.

The development of the Atlantic cargo steamship will be on ship-shape lines, and not in the way of fantastic patent ships. There should not be more than three complete decks, including a shelter deck, with a partial fourth deck in forehold only. The shelter deck is practically necessary for the American trade. The space covered by the shelter deck must necessarily be exempt from measurement for tonnage dues, except when used for freight or cattle. It is reasonable and necessary that it should be so treated, because it is not required for heavy cargoes, and adds greatly to the surplus buoyancy and freeboard, and to the safety of the ship and crew; while the expense of paying tonnage dues on this space, when not carrying freight in it, would be practically prohibitive. With a complete shade deck there is no need for the further addition of a long bridge house, either for more space or for safety, and such further erections are undesirable. Nothing more is advantageous above the shelter deck, in a cargo steamer, than houses for the accommodation of the officers, and for sheltering the steering gear; with steering house and chart house 8 ft. above the deck and pilot bridge 15 ft. above it. With these the height from the keel to the pilot bridge will be about 60 ft. As an instance of a greater height, plans have been submitted to his firm for building a steamer over 90 ft. from the keel to the top of the steering house.

The specifications should not be allowed to include any items that will not earn 20 per cent. per annum on their cost, to cover insurance, depreciation, interest, and profit. The steel decks need not be sheathed with wood, neither should wood sheathing be fitted on the double bottom. He might pass over the question of cargo discharging appliances, beyond saying there is no need for a donkey boiler, and there should be not less than twelve to fifteen steam winches of the best description. It is a question for consideration whether there should be any masts, sails, etc., or not.

As regards strength, his experience has been that with good work, Lloyd's scantlings for large steamers, with some little additions, have proved sufficient for Atlantic weather. The largest ships they had built had proved perfectly strong enough, after three or four years' work. Further experience is required to prove whether the larger steamships built on the present rules will stand

*A paper read before the Institution of Naval Architects, and published in the *Engineers' Gazette*, England.

[1] The author strangely ignores the enterprise of German steamship lines in this direction. There are many more steamships of 10,000 tons and upwards sailing under the German flag than under the British. His explanation would probably be that they are not exclusively cargo vessels.—ED. M. E.

ten years' heavy Atlantic work equally well. It is probable that they will. Those built by his firm are stronger in the shelter deck than Lloyds' rules require, but in other respects some of them are built simply to the rule scantlings. Of course it is necessary to pay special attention to the strengthening of deck and side openings, and to any places such as the ends of bridge deck house and the corners of hatchways, where there is a sudden termination of a rigid structure, or concentration of stresses. The number of rivets, spacing, and size, also require special attention. The attachment provided by the latest rules for the frame-feet to the margin plates of the double bottom is insufficient and should be greatly increased. Some other questions of local strength might be discussed, but structurally considered, the materials and scantlings at present in use appeared to be sufficient.

Very few Atlantic cargo steamers have sufficient water ballast. From some of the Continental ports considerable quantities of outward cargo can usually still be shipped. From British ports, our somewhat one-sided free trade, together with the McKinley tariff, has so diminished exports to the United States that except to a certain extent by some special lines, there is no outward cargo, or scarcely any, to be carried. It is necessary, therefore, to make the outward passage in ballast, that is to say water ballast. The 500-ft. 12,000 tons deadweight steamer should have not less than 4,000 or 4,500 tons of water ballast, of which 1,700 tons can be carried in the double bottom tanks, 2,000 tons in two "deep tanks," one aft and one forward, at about the quarter length, midway between the engine and boiler space and the stem and stern, and 800 tons in "'tween deck" tanks between the main or upper and first lower decks. The latter are to be preferred for part, if not the whole, of the additional water ballast above that carried in the double bottom tanks, not only in order to raise the center of gravity of the ballast, and so ease the motion of the vessel when rolling, but also because the 'tween deck tanks, if properly designed, reduce broken stowage as compared with the "deep tanks," and are more convenient for loading and discharging than the deep tanks. They should be fitted between transverse bulkheads the full breadth of the 'tween decks. The position of the deep tanks should not be immediately before or abaft the machinery space. If placed immediately before the boiler room, a deep tank will sometimes interfere with convenient bunkering arrangements; and in any case, with the weight of the engines and boilers and of the bunker coals for both the outward and the homeward passage, necessarily concentrated in the middle of the ship, 2,000 tons of additional weight as water ballast cannot be placed in the middle without causing some alteration of form and also causing undesirable strains on the shelter deck and possibly on the engines and shafting. On the other hand, large peak tanks in the extreme ends of the ship are undesirable as promoting pitching, vibrations, and uneasy motions. A large addition might be made to the water ballast carried in the double bottom by carrying the inner bottom straight through to the shell plating at the upper part of the bilges, and he was not aware of any reason why shaft tunnels should not be used for water ballast as had been proposed.

The questions of propelling machinery and speed are not at the present moment very difficult, with an exception that may be referred to further on. Large steamers are more easy and economical to drive than small ones. When they run in a regular line in turn with smaller steamers, it is desirable for them to be fast enough to make up on the voyage for the longer time they take in port to load and discharge than the smaller steamers. In the Atlantic larger power is required than for Eastern trades. It is understood that one at least of the great lines trading to the East is carrying cargo at only 9 knots. With head winds, steamers of similar power to that in the Atlantic would be reduced sometimes to about 6 knots. The A steamer, 11,700 tons deadweight, and B steamer, 11,500 tons deadweight, steam 11 knots average loaded, consuming 45 tons per day of north-country coals; the C steamer, 10,700 tons deadweight, 12 knots, consuming 52 tons per day (those steamers have forced draught but not Serve tubes). The three-cylinder triple-expansion engines, with single-ended boilers working at 180 to 200 lbs. pressure, and Howden's system of forced or Brown's system of induced draught, are economical and durable, and as satisfactory, on the whole, as any other design that has been tried. This statement must be made, subject to further experience of the effect of forced or induced draught on the durability of the boilers. It is largely a question of care and intelligence in working the boilers, but so far, with careful and skilful handling, there is no reason to believe that forced draught boilers need be short-lived.

The point of difficulty referred to is the question of shafting, and particularly of the propeller shafts. It is recorded in "Lloyds' List" that 173 steamships were disabled in 1898, mostly in the Atlantic, through fracture of shafting. It is stated that fifty-three similar accidents occurred in April, May and June this year. This can only be regarded as highly unsatisfactory. The causes usually assigned for these accidents are—the practice of steaming outwards from Europe to American ports in ballast, and generally with very insufficient ballast—the lightness of steel ships, and the reduction of their draught in ballast trim due to their floors and their lower lines forward and aft, having been made so much fuller than formerly. He did not consider these causes entirely sufficient to account for the remarkable increase in the number of shafting casualities that had occurred during the last two years. They undoubtedly have much to do with the trouble, but some of them have been in operation for many years. It may be taken as established that the diameters of shafting, and particularly of propeller shafts, as required by the rules of the Registry Associations and the Board of Trade have been, and are still, insufficient. The Committee of Lloyds' Register have already increased their requirements for propeller shafts about 16 per cent., and it is believed that they have under consideration the necessity of a further increase. Greater attention is being paid to the protection of propeller shafts from corrosion and from sudden diminution of strength at the outer edges of the brass liners. These improvements will tend to diminish shafting casualties, but they will probably not be found sufficient to prevent them. It may be necessary to go back to the practice of having an outer bearing for the tail-end of the shafts, but for reasons for which he need not enter into, he did not recommend it. He should, in large

single-screw vessels for Atlantic service, recommend increasing the strength of the propeller shafts 100 per cent. above the present rules.

There is reason to believe that during the last three or four years not only has the practice of running steamships across the Atlantic in ballast increased, but the captains and engineers, having grown bolder and more accustomed to it, have been less careful to slow their machinery down to half-speed in bad weather when the vessel is pitching and racing badly. With the old compound engines governors were used, and were at least of some use, and in very bad weather the engines had to be slowed or the machinery would have been shaken to pieces. With three-crank triple engines governors are less effective, and are now seldom used, and the main engines are not so severely tried by running through heavy seas as with two cranks. But the propellers and propeller shafts bear practically the same strains with triple engines as with compound. The shafting is smaller in diameter, as compared with the power of the machinery and the size of the ships, than under the old rules for compound engines. The bending strains on the tail-end shafts, when the propellers are only partly immersed and the blade strikes the sea, are as great, if not greater, in new steamers than they used to be in the old compound steamers.

Considering the enormous and incalculable strains brought on the propeller shafts, with the vessel pitching and the engine "racing," there is no reason for surprise that propeller blades and shafting are frequently broken at sea. Unless it be made impossible to run the engines more than half revolutions when in "racing" weather, it may be doubted whether an increase of even 100 per cent. above the present rules would be sufficient to prevent fractures.

For large steamers carrying 10,000 or 12,000 tons of valuable cargo, the ship and cargo being valued at perhaps $1,500,000, duplicate engines and screws should be provided. In addition to the immense advantage of having an additional propeller in the event of one breaking down, the advantage of being able to use smaller screws when running in ballast is very considerable, and in a bad weather passage will often shorten the voyage. It may be taken that twin engines increase the first cost, and usually increase the space occupied, and in fine weather are less efficient by about 5 per cent. Yet these disadvantages, together with, in most cases, a slight increase in the cost of working, are more than outweighted by the increased safety from breakdown and disablement at sea. In ships of about 500 ft. long or more it may be said that twin engines are also necessary for handling the steamers in confined spaces.

It would be interesting to know the experience of other builders, but our own experience has been that the cost of building with the ordinary appliances is considerably greater per ton in very large ships than smaller ships. The cost per ton diminishes as the ship increases in size up to 5,500 or 6,000 tons deadweight, but gradually increases from 6,000 tons deadweight upwards. This increase is partly due to the larger ships being usually built on an improved and less simple specification, but is also largely due to the greater expense of handling the increased weight of frames, beams, and other parts of the vessel, and the increased height to which the weights have to be lifted while building. The expenses of shoring and keeping very heavy ships in shape are also considerably greater, even than in proportion to the increased size of the ships.

The increased cost of handling the materials for big ships finally determined my firm to provide steam or electrical power, not only for hoisting the materials, but for transporting them and placing them in position. In considering the structural arrangements necessary for supporting overhead cranes, the advantages to be gained by protecting the workmen in our uncertain climate from the weather appeared so great, that we determined to provide not only lifting appliances, but a complete shelter over the shipbuilding berths for the larger class of steamers we were building. They now, therefore, have covered-in sheds 500 ft. long, with glass roofs and closed-in sides from about 14 ft. above the ground upwards, over two of the building slips. In each of these two electric traveling cranes are provided on rails running the full length, and with jibs revolving below the cranes, so that any part of the ships building can be reached. One of the shed roofs is also used to support an outside cantilever crane commanding a space of 500 ft. in length by 60 ft. in breadth, on which a third steamer can be built.

It has been found that the work can be carried on much more quickly and economically under those sheds than under the old conditions. It has also been found, contrary to the prophecies that were uttered, that the ships under the sheds are more comfortable to work at than the ships built outside. The temperature under the sheds is higher in winter and lower in summer than outside, and though they are open at the ends and at the bottom, there has been no complaint of draughts. It has also been found that there is, together with a saving in the cost of staging and increased safety, a saving in the cost of shoring and fairing the vessels, as the columns supporting the roofs are freely used as abutments for the shores, which are consequently much lighter and more handy to use than if required to reach from the ground.

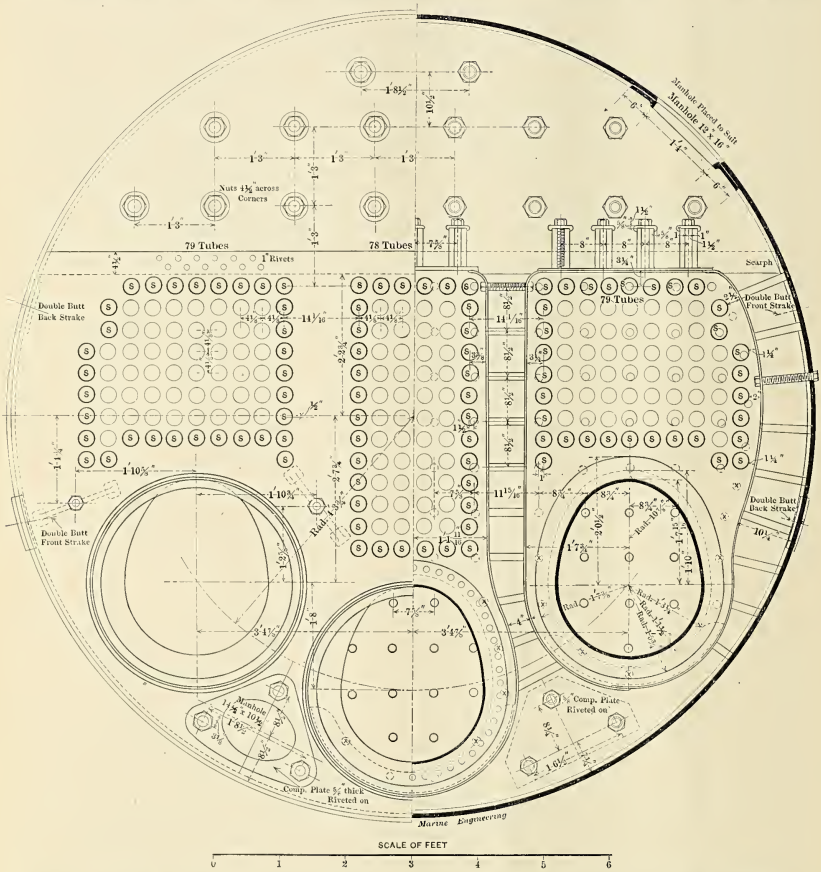
The one disadvantage (which was foreseen) is that although the roof and most of the sides are of glass there is a slight diminution of light, which has to be met with by increased use of electric lighting.

Wireless Telegraphy.—A practical test of the Marconi system of wireless telegraphy, under the supervision of the inventor, William Marconi, will be made during the forthcoming international yacht races at New York. Arrangements have been made by the *New York Herald* by which the races will be reported from the new steamship *Ponce,* of the New York & Porto Rico S. S. Co., and the steamship *La Grande Duchesse,* of the Plant line, both of which will be fitted with the Marconi apparatus. Signor Marconi is now in this country, having come over recently with the necessary instruments and two assistants. Messages will be sent from the ships so fitted to a cable ship, which will be fitted with the receiving instruments and which will be anchored near the Scotland Light Ship. From the cable ship the messages will be transmitted to the city by the submarine and land wires.

The purchase of the late Baron Ferdinand de Rothschild's steam yacht *Rona* by Amzi L. Barber, member of the New York Yacht Club, has been reported.

TYPE OF FIRE TUBE BOILER ADAPTED FOR TUG-BOAT SERVICE.

It is a peculiar fact that in no class of boats is there less progress shown in construction than in tug boats. Of the great number of this style of craft plying in our harbors, rivers and lakes, many of small size, and even some of the large and powerful boats, are still equipped with single cylinder engines and old-style boilers. In latter years the two cylinder compound engine has widely come into use, but the old styles of boilers still remain. By far the greater number of boats use the leg boiler, and occasionally the long cylindrical boiler built up in brick work similar to a factory boiler is used. The leg boiler no doubt has proven to be very serviceable, especially in small outfits having 30 sq. ft. of grate or less, where the high roomy fire-box has a decided advantage over two cylindrical furnace-flues of small diameter in the Scotch type, and the reduction of diameter of shell allows more room at the sides of the boiler. On the other hand, the water legs are so narrow that they soon become filled with scale, and as it is almost impossible to clean them through the small handholes, it often happens that the leg portions require to be renewed after a few years' service. Furthermore, this style of boiler cannot be used for pressures much over 125 lbs., owing to the excessive amount of bracing necessary, which would render it almost impossible to get around inside. The almost universal use of the Scotch boiler in sea-going vessels has demonstrated its capabilities in all kinds of continuous and hard service, and the question is often raised as to the reason why it is not used to a greater extent in tug boat service. Tug boat owners often as-

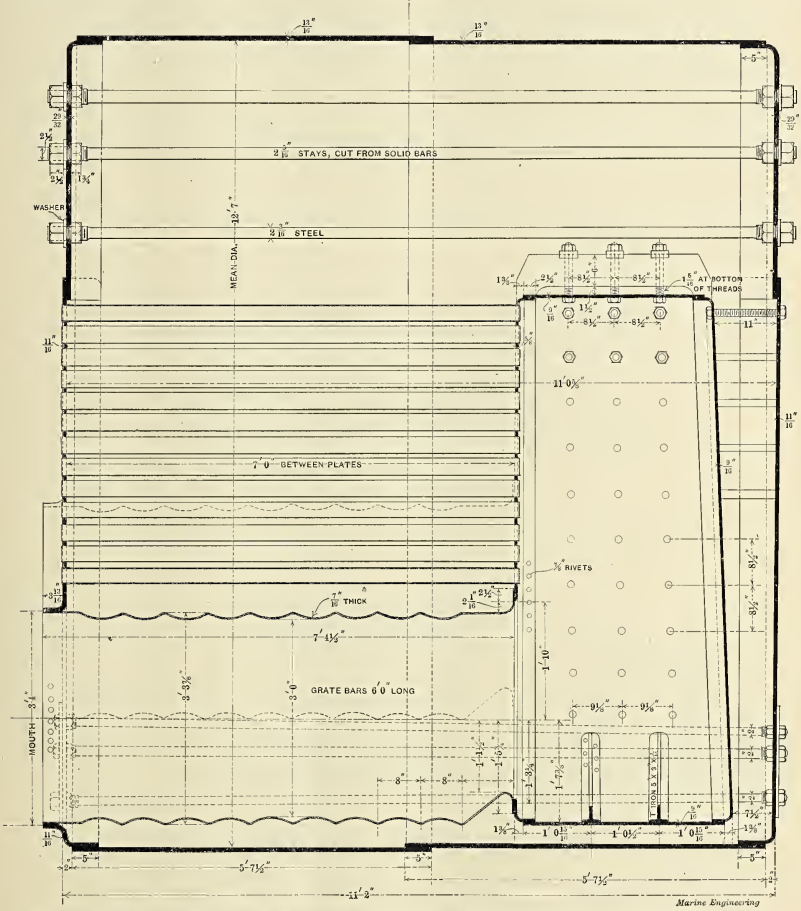


WORKING DRAWING OF THREE-FURNACE, SINGLE-ENDED SCOTCH BOILER, WITH INDEPENDENT COMBUSTION CHAMBERS.

sert that they would not consider the installation of any other style of boiler than the leg boiler, and give as a reason that leg boilers are cheaper in the long run.

This antipathy can be easily understood on looking over the designs of several so-called Scotch boilers tried in tug boat service. As stated before, the use of small Scotch boilers for this purpose is not good engineering practice, owing to the necessarily small diameter of the furnaces.

In one case which recently came under our notice, the designer had placed two large furnaces in a comparatively small shell, the result being that the furnaces were a considerable distance from the bottom, and the space for the return tubes was very cramped. As a consequence, in order to get a reasonable amount of heating surface the boilers had to be made quite long. With such a large quantity of dead water under the furnaces the boiler could not be worked satisfactorily, and this lack of appreciation of working conditions by the designer caused the condemnation of the type in this particular instance. In another case, a boiler was built with a narrow combustion chamber common to all furnaces, with sides close to the shell, the return tubes being arranged in a solid bank from side to side and extending up to such a height in the boiler as to reduce the volume of steam space and the steam liberating surface to almost one-half of what

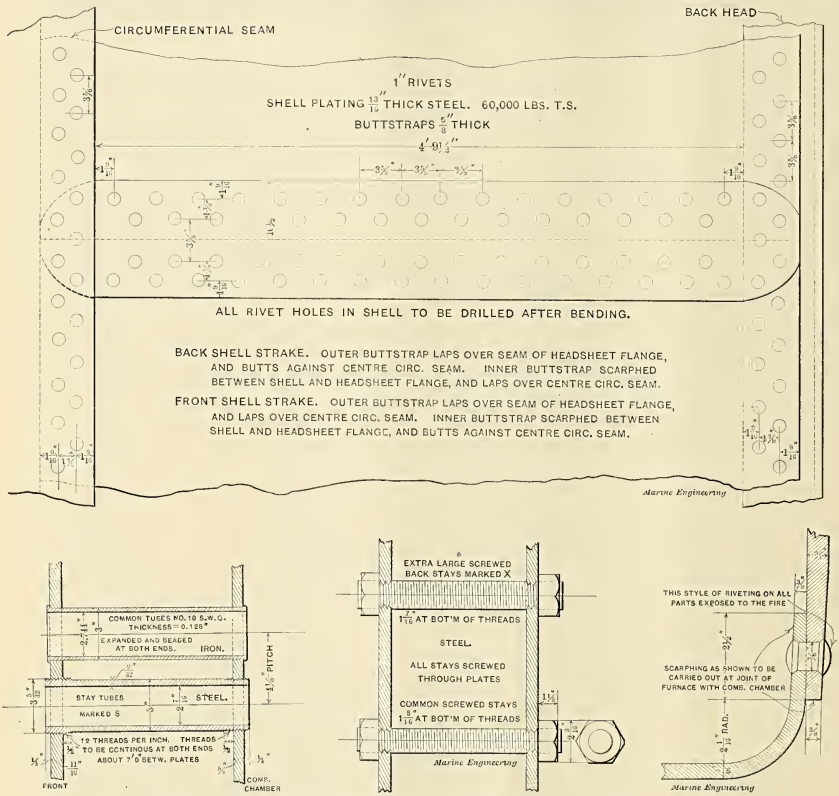


SECTIONAL VIEW OF THREE-FURNACE, SINGLE-ENDED SCOTCH BOILER WITH INDEPENDENT COMBUSTION CHAMBERS.

they should have been. A boiler so designed, while possessing a large amount of heating surface, must of necessity rapidly deteriorate owing to the impossibility of getting at the interior surfaces to clean and scale the boiler. Without going into details of other designs, it can be said that the failure of the Scotch boiler in tug boat service heretofore has been due in almost every case to faulty design.

The building of this style of craft is still greatly a matter of rule of thumb, and the question of first cost is often given undue prominence—from an engineering standpoint—in the considerations which precede the giving of an order by a tug owner. Good designs are like anything else worth having, they cost more than poor or "inexperienced" designs, but probably as long as tug boats are a necessity, so long will there be owners who only consider first cost, and take no proper account of operating expenses and repairs.

With the gradual rise in boiler pressure during the past few years the Scotch boiler is being forced on the attention of tug owners, and taking its place in the better class of tug boat construction, especially in those cases where triple-expansion engines are installed. In the accompanying scale working drawings, a design for a boiler to carry 125 lbs. pressure is shown. This boiler was built some time ago and has seen a good deal of hard service, which it has responded to very adequately, and has been an entirely satisfactory investment for the owner. An examination of the design shows that it has ample heating surface, as well as large steam space, and large steam liberating surface; and this, in combination with the independent combustion chambers, is conducive to steady steaming. Every part of the boiler is easily accessible for cleaning and repairs. The furnaces are of the Morison type, with the Gourly flanged ends, so that they may be easily withdrawn when necessary to renew them without disturbing any other part of the boiler. The whole design is, in fact, based on modern practice for first-class seagoing vessels, and the result, as anticipated, has fully come up to the expectation of the builders. Bituminous coal is the fuel used.


BACK HEAD
CIRCUMFERENTIAL SEAM
1" RIVETS
SHELL PLATING 13/16" THICK STEEL. 60,000 LBS. T.S.
BUTTSTRAPS 5/8" THICK
4' 9 1/4"
ALL RIVET HOLES IN SHELL TO BE DRILLED AFTER BENDING.
BACK SHELL STRAKE. OUTER BUTTSTRAP LAPS OVER SEAM OF HEADSHEET FLANGE, AND BUTTS AGAINST CENTRE CIRC. SEAM. INNER BUTTSTRAP SCARPHED BETWEEN SHELL AND HEADSHEET FLANGE, AND LAPS OVER CENTRE CIRC. SEAM.
FRONT SHELL STRAKE. OUTER BUTTSTRAP LAPS OVER SEAM OF HEADSHEET FLANGE, AND LAPS OVER CENTRE CIRC. SEAM. INNER BUTTSTRAP SCARPHED BETWEEN SHELL AND HEADSHEET FLANGE, AND BUTTS AGAINST CENTRE CIRC. SEAM.
Marine Engineering
COMMON TUBES NO. 10 S.W.G. THICKNESS = 0.128"
EXPANDED AND BEADED AT BOTH ENDS. IRON.
STAY TUBES STEEL. MARKED S
12 THREADS PER INCH. THREADS TO BE CONTINOUS AT BOTH ENDS ABOUT 1" D SETW. PLATES
PITCH
FRONT
COMB. CHAMBER
EXTRA LARGE SCREWED BACK STAYS MARKED X
1 7/16 AT BOT'M OF THREADS
STEEL.
ALL STAYS SCREWED THROUGH PLATES
COMMON SCREWED STAYS 1 5/16 AT BOT'M OF THREADS
Marine Engineering
THIS STYLE OF RIVETING ON ALL PARTS EXPOSED TO THE FIRE
SCARPHING AS SHOWN TO BE CARRIED OUT AT JOINT OF FURNACE WITH COMB. CHAMBER
RAD.
Marine Engineering

DETAILS OF SINGLE-ENDED SCOTCH BOILER TO CARRY 125 LBS. STEAM PRESSURE.

ELECTRIC vs. STEAM PROPULSION FOR TORPEDO BOATS IN THE LIGHT OF PRESENT PRACTICE.*

BY CHARLES T. CHILD.

The progressive evolution of the modern torpedo boat from the spar and bomb craft of the American civil war has reached its apparent limit along the lines of its more recent development. The steam launch making 7 or 8 knots has grown into the 30-knot seagoing torpedo boat, armed powerfully for offense with automobile torpedoes and carrying a few light guns for defense. To attain the high speed demanded in a torpedo attack, everything has been sacrificed in the design of such boats to the necessity of floating the most powerful machinery in the lightest hull. The results attained challenge admiration when speeds and horse-powers alone are considered, but the craft themselves are adapted to the true tactics of torpedo warfare only in the one particular of speed. When the far more important qualities of silence, invisibility and safety are considered, it is evident that the steam-driven boats enjoy none of them, and that little more can be expected than has already been attained in any of these directions. It is true that the steam turbine seems to hold out possibilities of somewhat higher speeds, but even with the turbine, in boats of small size, it is not likely that any great increase of speed will be made. Of course, if the boat is made larger, higher speeds may be attained, and it does not seem impossible to reach even such a speed as 40 knots with boats of 300 or 400 tons, but the natural question arises as to whether a gain in speed at the expense of secrecy—for the bigger the boat the easier it is to see—is advisable and whether such vessels should have a place in torpedo manœuvres.

The torpedo boat is simply the expression of the principle underlying all strategy—the infliction upon the enemy of a vital blow, costly to him in life and property and terrifying in moral effects, at the least cost in property and life to the attacking party. In other words, a combat between a torpedo boat and fighting ship means that a few men in a little, inexpensive vessel take desperate chances to destroy many men in a large, costly vessel. If the danger of detection and annihilation to torpedo boats be minimized, the value of these vessels will be enormously enhanced. The nation owning a swarm of these wasps of the sea could make its coast safe from attack and erect a barrier of terror that the stoutest sailor would not dare to pass. What chance would a battleship have if simultaneously attacked by five or six boats of, say, 25-knots speed, each armed with automobile torpedoes? It would doubtless sink some torpedo boats, but it would as certainly be destroyed. Assuming, then, that a proper theory of torpedo attack is to risk as little as possible and to make assurance sure by launching a number of boats at once against an enemy so as to divide his fire, it is well to see how the present craft plays its part under such circumstances before discussing the radical innovation which is proposed below.

In the first place, it ought to be said, in justice to the torpedo boats of our navy, which have been maligned by thoughtless critics for what they did and did not do in the recent war, that a torpedo boat is neither a cruiser, a dispatch boat, a yacht, or a coast-guard ship. When highly specialized and necessarily delicate structures such as these are put to work doing duty for which they were never meant, day in and day out, with no base for repairs, no chance to get fresh water and absolutely no fit accommodations for their personnel, it is a matter of wonder and congratulation if all of them are not utterly ruined.

It may be laid down as an axiom that a boat built for torpedo service has to be so specialized as to be unfit for any other duty. The requirements are speed, silence, invisibility, quickness in manœuvre, and the smallest possible crew. A seagoing, cruising torpedo boat is a sort of anomalous contrivance, developed out of the struggle for speeds, and is not, properly speaking, a torpedo boat at all. It is not expected to make torpedo attacks on the high seas. They are directed at blockading vessels, ships lying in a harbor, and in general, at vessels near shore and not going at full speed.

For the boats to be invisible they must be small. In the case of steamboats the visibility is heightened by the smoke and the stacks, while the chances of flaming funnels under forced draft are very good. These convert a torpedo attack into a sort of marine torchlight procession, considerably more dangerous to the attacking party than to the attacked.

Silence is simply an impossibility with a steam craft. The engines will rack and jar, the fans will purr, and the steam, lashed up under the excitement of an attack, will probably blow off.

From all these considerations, then, it is seen that steam torpedo boats making an attack at night (it is needless to say that a torpedo attack in daylight is suicidal folly) will have to run the gauntlet of no less than four dangers of their own making. The enemy is keeping a vigilant lookout and sweeping the waters with his searchlights. The boats must slip into their striking distance—a few hundred yards—without discovery. Suddenly a shower of sparks from a funnel, a hiss of high pressure steam blowing off, a roar of fans and light engines running at furious speeds proclaim the presence of boats and the location of one of them. That one, at least, is apt to be immediately destroyed.

Seeing, then, that the steam-propelled boat has certain vital defects, is it not possible to imagine a vessel free from the dangers that beset the present-day torpedo boat? Cannot another motive power, simple in its application, powerful and silent and controllable, take the place of the snarl of water-filled tubes, the furnaces fanned to destructive heats, the complex engines with their multitude of reciprocating parts flying at fearful speeds under the impulse of high-pressure steam, the ghastly infernos of the fire-rooms, where suffocating men run risks of a dozen kinds of death even in a peaceful cruise? The purpose of this brief sketch is to show that this can be done with that certainty of success that should warrant the attempt.

Let it be assumed that a boat of moderate size has its boilers, coal and engines replaced by accumulators

* From the Journal of the American Society of Naval Engineers.

and electric motors. It is perfectly evident that if such a boat can show the speed of the steamboat, it is superior to it in all the essentials of silence, invisibility and manœuvring power described above, as well as in a smaller crew required and the consequent smaller risk of life in an attack.

To illustrate the present possibilities and limitations of such an application of electric power it is easiest to take a concrete case and show what results can be obtained with the motor equipment.

A boat about 140 ft. long, having a beam of 14 ft. and a draught of 5 ft., will displace, light, 110 tons, and carry normally 30 tons of coal. If 45 tons is allowed for the weight of the hull, ammunition, crew, stores, etc., there is left 95 tons, or 213,000 pounds, for the electrical equipment.

To attain a speed of 22 knots about 1,500 horse power will be required. As the torpedo boat goes at full speed only at the instant of the attack, the motors installed should be such as to work economically at lower speeds, should weigh as little as possible, and should be worked up to their utmost maximum of output for the rush of attack. Without going at length into questions of motor design, it may be said that four motors, each developing 400 horse power at its maximum, are indicated. These, by careful design, using laminated iron in the fields, may be reduced to a weight of 6,500 pounds each, or 26,000 pounds for the four. This leaves 187,000 pounds for the battery, circuits and controller or switching devices. Allowing 12,000 pounds for these latter, and 175,000 pounds for the battery, what performance can be expected of the boat?

In a concourse of automobile vehicles held in France during the past summer, a number of types of light and very powerful accumulators were brought out and given a hard, practical service test by a commission appointed for that purpose. Taking the figures given by them for the performance of the average cell, the 175,000 pounds of accumulators will maintain an output at the screws, the losses in conductors and motors being included, of about 140 horse power for twenty-four hours; 300 horse power for ten hours; 520 horse power for five hours, and 2,000 horse power for one hour—a power that would give a rush speed of as much as 25 knots. At the twenty-four hour discharge rate the speed would be about 9 knots and the cruising radius about 216 nautical miles.

From these figures it is perfectly evident that this craft is fitted to discharge the normal functions of a torpedo boat with entire satisfaction. It has sufficient range at slow speed to travel to some distance from its base. It has a rush speed equal to or greater than that of a steam-driven vessel of the same size. But, above and beyond all this, it has silence, secrecy of movement, absolutely instantaneous and certain control, and other points of advantage so great as to far outweigh the disadvantage of a short radius of action. A comparison of the operative efficiency of the two types, steam and electric, may be interesting.

A steam vessel of this class would carry two officers and about eighteen enlisted men, a total of twenty lives. The electric boat would need only enough men to launch the torpedoes, one officer and five men at the outside. The cost of the boat would be about the same with either system of propulsion. From this it is seen that the risk of property in an attack is the same in the two cases, while the risk of life with the electric boat is far less, the destructive and offensive powers of the electric craft being the same or greater.

It will be at once conceded that a boat without stacks, without smoke, without possibility of a flaming funnel is less visible and less apt to attract the attention of the attacked ship than one of the ordinary type. In the matter of silence there is no high-pressure steam on the electric boat, no boiler tubes to burst and vomit up a small volcano of ashes and fire and steam through the stack, no fans that cannot be stopped during an attack (these would be ventilating fans, of course), no racketing reciprocating engines penned up in a sheet-steel sounding box. It slips through the water in silence and darkness, its low freeboard having no other projections than the conning tower and signal mast.

In the conning tower, or whatever corresponds to a conning tower on a torpedo boat, is the steering wheel and a "controller" precisely similar to those on electric street-car platforms, though somewhat larger. With the handle of this in one hand and the steering wheel in the other the officer in charge of the electric boat has the whole craft absolutely bridled. Every other man aboard may be put out of action and yet a successful run made. There is no transmission of orders—no excited shouting in the noise and steam and sweat of a reeking engine-room—but only the instant and silent answer of the motors to the touch of the controller handle.

The storage battery and motors, both being intrinsically heavy, can be stowed in very small space, well below the water line, and a thin deck worked over the whole. The entire upper works of the boat might be shot away without putting it *hors de combat.* A single well-directed shot, unless it sunk the boat, could do no vital harm, because there is nothing to harm. Both battery and motors, being perfectly divisible, may be placed in numerous compartments, and the electric boat thus so divided that its chance of surviving injury would be greatly increased. The circuits are run in duplicate or triplicate. There are four or five controllers in different parts of the boat, and among the four motors one would always be left in service. A shot from an ordinary small rapid-fire or machine gun would not damage the motors, and if it wrecked a few cells of the battery they could be "bridged across" in a few seconds. Indeed, by using many small cells in parallel groups, the battery could be made to do its work even if well riddled with small shot.

To discharge these batteries would take, ordinarily, four hours. In an emergency it might be done in one hour. They should be arranged to work at the standard pressure of the lighting and power circuits on the large naval vessels—80 volts—so that a boat could be charged from any full-powered ship. This could be done even in a heavy sea, as there would be no occasion for close approach, such as is required in receiving coal or water from the ship. A cable, which might be of any convenient length, would be the sole connecting bond between the vessels.

It has been shown that an electric boat risks fewer lives in an attack, has advantages of silence, invisibility

and manœuvring power, is less vulnerable and incomparably superior to a steam torpedo boat. The only advantage the latter can claim is cruising radius. Is this an advantage? There would never be any suggestions of using the electric boat as a dispatch boat or as anything but a torpedo boat. It is instantly ready for service. Once charged it can speed up to its highest velocity in a few seconds. It can be towed behind any steam vessel to the neighborhood of the enemy, and, once there, can work devastation impossible to any boat handicapped by the danger of being discovered and shot to pieces before it can discharge its torpedo.

This very rough sketch of the present possibilities of the electric torpedo boats is not offered as a solution of the difficult problems involved in their design. It has been written with the hope that it may provoke discussion in which the apparent importance and value of this method of driving may be well ventilated.

U. S. S. Alabama.—The preliminary builder's trial of the U. S. battleship *Alabama,* constructed by the Cramps, was held last month, and a statement was given out that she maintained an average speed in excess of 17 knots. The vessel is incomplete, as the side armor of Harveyized nickel steel is not yet in place. The *Alabama* is a sea-going coast line battleship fitted with two 13 in. barbette turrets, and armed with four 13 in. breech-loaders, fourteen 6 in. rapid fire guns, sixteen 6-pounder and six 1-pounder rapid fire guns, four Colt automatic guns and two 3 in. field cannon. She has also four torpedo tubes. Her dimensions are: Length on load water line, 368 ft.; beam, extreme, 72 ft. 2 1-2 in.; mean draught, 23 ft. 6 in.; displacement, 11,525 tons. Her estimated sea speed when completed is 16 knots. She is fitted with triple expansion engines of 10,000 I. H. P. and Scotch boilers. The *Alabama* was authorized by Act of Congress passed in June, 1896, which also called into being the battleship *Illinois,* building at Newport News, Va., and the battleship *Wisconsin,* building at the Union Iron Works, San Francisco. The *Alabama* is practically ready for service, with the important exception of her armor, the delay in completing her being caused by the armor plate dispute.

Rammed an Iceberg.—When the Anchor Line steamship *City of Rome* arrived at New York from Glasgow early last month she reported having been in collision with an iceberg in mid-ocean. The weather was very foggy at the time, and Captain Young was going dead slow when the iceberg was sighted a short distance ahead. The engines were sent full speed astern and consequently the vessel had very little way on her when she struck the iceberg. She slid up on a submerged portion of the berg and remained an instant or more in this position, until she slid off again and backed away. An examination showed that no serious damage had been sustained. The passengers were at dinner at the time, and for awhile there was considerable excitement. The officers and crew, however, behaved with such coolness and promptness in taking emergency measures that quiet was speedily restored, and when the safety of the ship had been ascertained the voyage was resumed without further incident.

LIMITATIONS TO THE APPLICATION OF ELECTRICAL PROPULSION TO TORPEDO BOATS.*

BY WILLIAM F. DURAND, MEMBER.

The application of electricity to marine propulsion has in recent years attracted the attention both of electrical and marine engineers, and the successful operation of the electric launches at the World's Columbian Exposition in 1893 gave to many strong hopes that the field of such application might be immediately widened to include small craft of all descriptions and for all purposes, and that the day was not far distant when even large craft as well—the liner, the freight steamer and the warship—would all derive their propulsive power from energy stored in the electric form. It was early recognized, however, that energy embodied in storage batteries is excessively expensive in weight as compared with energy embodied in coal, and furthermore that electric motors are usually heavier for the same power than the lightest types of steam engines. These facts introduced a prompt limitation to the extension of electric propulsion, especially to cases where high speed or long endurance was desired.

In a paper published several years ago the author showed the limitations and presented the possibilities of electric propulsion as given by the practice of that day. It may not be without interest to reconsider the same subject briefly, and to note what advances have been made since the publication of that paper. Especially may this be suitable at the present time in connection with the appearance of an article by C. T. Child† on the same subject.

The data which are used in the latter article and which are made the basis of the case as presented, seem to be considerably beyond current American practice, and undue expectations may perhaps be awakened regarding the readiness with which such results could be realized.

In regard to the fundamental values assumed for the torpedo-boat, it may be said that the power is perhaps a trifle low for the displacement and speed, and the fraction of weight available for machinery and propulsive equipment rather high, both tending, of course, to make a better case for the electrical equipment. These differences, however, are not of particular importance, for the question of the availability or otherwise of an electrical equipment rests on considerations of a more serious and fundamental character.

Let us then proceed to a comparison between an electrical and a steam propulsive equipment, using, in addition to the data taken by Mr. Child, such additional safe values from modern engineering practice as might naturally be made the basis of a business contract. We need first to specify units of *power* and *work* relative to which the comparison may be made. For these we shall take respectively the *horse power* delivered to the screw shaft, and the *horse power per hour* delivered to the screw shaft.

For the steam equipment we may allow 2.5 lb. coal per horse power per hour on the shaft. This will occupy about .05 cu. ft. bunker space. For the total weight

*From the Journal of The American Society of Naval Engineers, Washington, D. C.

† See page 151 of this issue.

of steam equipment, including engines, boiler and auxiliaries, all in steaming condition, we have values ranging from 40 lb. to 70 lb. per power unit on the shaft. Of this amount the engine-room weights furnish rather less than one-half and the boiler-room weights rather more than one-half.

Turning now to the electrical equipment, we must examine the weights of batteries and motor for the same units on the shaft. Taking first the batteries, we must distinguish two questions: (1) How much battery is necessary in order to actually attain a certain desired power, aside from the question of endurance? (2) How much battery is necessary in order to embody a given amount of energy, aside from the question of how rapidly it is used or how much power is developed? The two questions are not independent, and must be examined together.

In Fig. 1, *A B* shows the nature of the relation between the total capacity of a storage battery and the time of discharge, while *A C* shows the corresponding value of the discharge current. Beyond 3 or 4 hours the

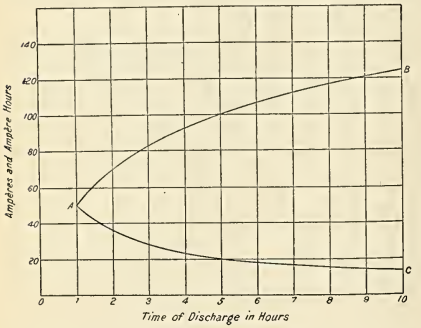


FIG. 1

Capacity in ampère-hours and corresponding current in ampères for varying time of discharge. For relative purposes the capacity at five-hours' discharge is taken at 10 ampère-hours.

total capacity more slowly increases with the time, as shown, while for a shorter period the total amount which can safely be taken from the cells quite rapidly falls off. The power which can be developed depends, then, simply on how rapidly the cells can be discharged, and is, of course, proportional to the discharge current, as shown by *A C*. The limit to the development of large power from a small battery is, therefore, the increasing danger of damage to the cells resulting from excessive rates of discharge, and the rapidly decreasing time during which the power is available. The normal discharge period is usually taken at from 8 to 10 hours, but with care it may, with the best types of cells, be safely decreased to 4 or 5 hours. For a few moments the discharge current may even be increased far beyond the values corresponding to these periods, but for what may be termed continuous conditions a rate corresponding to discharge in 4 or 5 hours is about the maximum usually employed.

If we take now the weights of the leading American storage cells as built for stationary purposes, and derive for the various rates of discharge the weight per *horse power per hour* of battery output, and of weight per *horse power* of output, we shall find values as represented by *A B*, Figs. 2 and 3, respectively. The increase of weight per work unit as well as the decrease of weight per power unit, as the time of discharge is decreased, are both clearly shown by the diagram. In

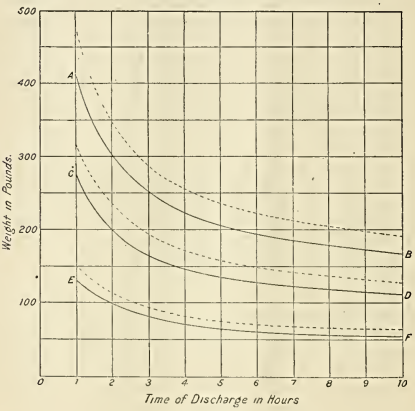


FIG. 2

Weight of batteries per H. P. per hour for varying time of discharge

these cells the weight of the lead elements is from 50 to 55 per cent. of the cell complete with acid and lead-lined wooden tank. In a somewhat lighter form of construction for cells of the same type the weight of the lead elements is about 65 per cent. of the cell complete, and the latter ranges at about two-thirds of the values shown

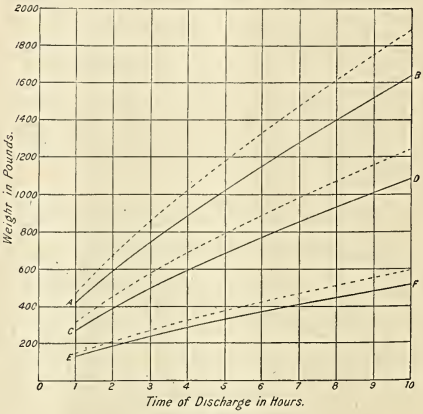


FIG. 3.

Weight of batteries per H. P. for varying time of discharge.

by the curves *A B*. These lower values are shown by the curves *C D* on the same diagrams. These figures and diagrams show what may be expected from commercial cells at present on the American market. As to possible reduction in the weight of this type of lead cell,

the future alone can determine. It is a significant fact, however, that these cells as built at the present day, are considerably heavier than those on the market a few years ago. This seems to indicate that for purposes of durability, reliability and continuity of operation, the heavier type of construction is preferred where the additional weight is not a special disadvantage.

Turning now to the results given by the report of the French tests of automobiles, as referred to by Mr. Child, we find an entirely different range of figures. In these cells the normal period of discharge is taken as 5 hours, and the figures for power output and capacity refer fundamentally to this period. At the same time the capacities for a discharge current double and half the normal value are also stated. These correspond to periods of about 2 and 11 hours. Between these limits the resultant capacity curve plotted on time agrees fairly well with similar data derived from American practice, and the curve AB of Fig. 1, which represents a series of mean values drawn from a considerable range of recent American data, may probably be taken as representing satisfactorily the relative capacity curve for the automobile battery as well.

In this battery the weight of the lead plates is about 70 per cent. of the cell complete. For the latter, the weight per horse-power output for a 5-hour discharge is 321 lb., and per horse power per hour output 64 lb. It will be seen that these figures are from about one-half to one-third those for the cells on the American market. They are represented by the curves EF in Figs. 2 and 3. As to how far it would be safe to expect that this lighter type of construction would be suitable for marine propulsion, it is difficult, from the description given, to form a satisfactory opinion. Until more evidence is forthcoming, however, their suitability to such uses may be fairly open to some doubt.

With regard to the space occupied, and basing the total output on the 5-hour discharge, we find for the American cells a space of from 1 to 1.4 cu. ft. per horse power per hour output, while for the lighter automobile cells the space required is about .5 cu. ft., or about in the same proportion for space occupied as for weight.

It will be noted that the above figures for batteries all refer to output. Assuming a motor efficiency of .87, we may reduce to similar units on the shaft by dividing by this ratio, an operation which will increase the several figures by about 15 per cent. of their former values. A uniform efficiency as high as .87 is more than can be expected, especially for the extreme conditions, but the error favors the electrical equipment, tends toward simplicity of treatment, and is not significant for the purpose in view, which is not so much to take account of all secondary influences as to show the general character of the results to be expected under the various suppositions made. In Figs. 2 and 3 the increased weights are shown by the dotted lines. For the space occupied the figures will be from 1.15 to 1.60 cu. ft. per horse power per hour for American batteries, and about .58 cu. ft. for the automobile battery.

Turning now to the motors, we find a wide variation in figures. During the past five years some advance has been made in the reduction of weights, and, taking values representing the best actual practice, we find from 30 to 50 lb. and upward per horse power on the shaft. The minimum figures correspond to revolutions per minute of not over 400 or 500 for the larger sizes. Some further saving might still be made by an increase of revolutions, but such saving is limited, for the weight of motors by no means decreases as the revolutions increase. Heating in the armature and poles, and structural considerations connected with the necessary space for insulation, etc., place an early limit on the reduction of weight by increase of revolutions. As suggested by Mr. Child, also, some further reduction might be made by more extended use of laminated iron in the field, but it may be fairly questioned whether so large a reduction as that implied in the figures given in his article could be hoped for. In any event, so far as the author is aware, motors weighing only 16 lb. per unit of horse power output are not the subject of current design; they are not on the market, and it is doubtful if reliable builders would care to guarantee weights much below the minimum stated above. If we take the best of present-day practice, as represented by motors actually built and ready for use, we shall not be able to go much below 30 lb. per horse power on the shaft for such motors as would be suitable for purposes of marine propulsion. We will, however, assume 25 lb. as presumably obtainable at the present time by special design.

Taking the figures given above, it results that for equal amounts of work delivered to the shaft, storage batteries, on the basis of a 5-hour discharge, weigh from thirty to nearly one hundred times as much as coal, and occupy from ten to thirty times as much space. For the same power delivered to the shaft, the electric motor will weigh somewhere about one-half the total weight for a steam boiler and engine, and rather more than the engine-room equipment alone.

It is quite evident that in an electrical equipment the weight of battery will be the chief item, and that the necessary weight will be determined by the maximum power required and by the safe rate of discharge at which this power may be developed.

If the maximum speed of the boat is to be considered as 22 or 25 knots, then in order that such a term may have any significance in a tactical or naval sense, it should be possible to maintain this speed for at least one hour, and, preferably, more; and it would seem unwise to use in the development of such a speed, for a period of an hour or more, a discharge current higher than that corresponding to a 4-hour complete discharge. It is true that a boat thus equipped could make rushes of short duration at a much higher rate of speed, but to be of tactical value their safe duration should extend beyond periods of a few minutes. It may be here noted that in the report of the French Commission on automobiles, the maximum discharge considered as allowable for anything beyond momentary rushes of current is that corresponding to complete discharge in about 3 1-4 hours, a current one-third above the normal for a 5-hour discharge. A further limitation arises from the rapid loss of safe total output at excessive rates of discharge, so that the relative endurance rapidly decreases as the discharge current is increased.

Thus, according to the law indicated in Fig. 1, a doubling of the discharge rate for a 4-hour period will reduce the endurance to one-fourth its value, or to about one hour. The qualities of a torpedo-boat and the conditions which she should fulfill are, of course, largely matters of opinion; but taking into consideration ques-

tions of tactics and safe endurance, it would seem as though a requirement of full speed for one hour at a discharge rate not exceeding that for a 4-hour endurance, or a possibility of full speed for 4 hours, is little enough to require of a boat intended to meet the probable exigencies which may attend the operation of such craft. Taking the values from Fig. 3 for a 4-hour discharge, we find that for a 140-ton boat, with 2,000 shaft horse power, the weights required would be, for American batteries, from 1,400,000 to 2,000,000 lb. in round figures, and for the automobile battery about 650,000 lb. In any case the weight required is several times the total displacement of the boat, and hence entirely out of the question. For 1,500 horse power the weights would be three-fourths of the above amounts, and hence equally unattainable.

It is thus clear that the requirements as laid down, and as they might naturally be taken, having in view the results attained by steam equipment, are entirely out of the question. Even in the case of the automobile battery, regarding the suitability of which we may still reasonably doubt, the weight required for batteries alone is about twice the total displacement of boat. We may then naturally, as does Mr. Child, approach the question from another standpoint, and, taking a certain amount as disposable for motor and batteries, investigate the possibilities.

To this end let us assume that the motors are to be rated normally for the power which would be developed with the 2-hour discharge current. They could then stand, for short periods, increased rates of discharge up to that corresponding to a 1-hour endurance. This would provide for the possibility of short rushes at excessive rates of discharge and developed power, and the motors would, of course, be more than ample for lower rates and longer periods of endurance. For a 2-hour discharge current, according to Fig. 3, American batteries will weigh from 440 to 660 lb. per horse power on the shaft, and the automobile battery about 210. Adding say 25 lb. for motor, we should have respectively the figures 465 to 685, and 235.

Out of the total displacement of 140 tons we will take, for our present purpose, the same amount as that assumed by Mr. Child, viz.: 201,000, as disposable for motors and battery. Dividing this weight by the above figures, we should find for the rated motor powers, respectively, 293 to about 430, and about 850. The corresponding motor weights would be, respectively, 7,325 to 10,750 and 21,250. The balance available for battery would be, respectively, in round numbers, 194,000 to 190,000 and 180,000, and on the basis of the laws expressed in Figs. 1 and 3 we might expect results somewhat as given in the following table (next column):

A boat with capacities as given by these figures may be made use of in a variety of ways, but even in the most favorable case such a craft is not a torpedo-boat. So far as the use of the results from the report of the French Commission on automobiles is concerned, the chief difference between these figures and those derived by Mr. Child is in the possibilities at excessive discharge rates. Experimental information on this point does not seem to be given in the report. The normal rate of discharge was considered to be that for a 5-hour period, for which the figures as taken from the report have been given here. In addition, statements were made regarding the capacities at double and half the normal rates of discharge, as previously noted. In the actual tests as shown by the time of run and by the graphic logs of the discharge currents, the mean rate was only slightly above the normal, though momentarily it rose to values two or three times as great. The general law connecting safe capacity with the time of discharge, as shown

Time of Complete Disch'rge	Heavier American Battery.			Lighter American Battery			Automobile Battery.		
	Power.	Speed.	Endurance.	Power.	Speed.	Endurance.	Power.	Speed.	Endurance
1.....	412	15.2	15.2	618	17.2	17.2	1,320	21.0	21
2.....	290	13.6	27.2	435	15.5	31.0	929	19.5	39
3.....	2 8	12.7	38.1	342	14.4	43.2	730	18.0	54
4.....	190	12.0	48.0	285	13.5	54.0	609	17.0	68
5.....	164	11.4	57.0	246	12.9	64.5	535	16.4	82
10.....	103	9.9	99.0	155	11.2	112.0	330	14.1	141
24	52	8.0	192.0	78	9.0	216.0	167	11.5	276

in Fig. 1, and particularly for very small periods, has been already referred to; and extending such general law to the lighter automobile cell, it follows that the expectation of 2,000 horse power for 1 hour, based on the actual performance of about 500 for 5 hours, is far beyond what is likely to be realized. This would require a safe capacity for one hour of about 80 per cent of that for 5 hours, an assumption requiring the same general rate of decrease between 5 hours and 1 hour as is usually found between 8 or 10 hours and 5 hours. Available data shows that this expectation is far from any probable realization.

Even if the automobile battery were found well suited to marine propulsion and the full results as derived by Mr. Child were obtainable, the resulting boat would be of problematical value, for the utility of a torpedo-boat with an endurance of only 25 miles at full speed may fairly be called in question. What should we think of a like torpedo-boat with steam equipment developing 2,000 horse power, and carrying only about 2 tons of coal instead of 20 or 30 tons?

Let us now turn briefly to the possibilities under steam equipment with the same weights available for propulsive purposes. Taking the total weight of 213,000 lb., as assumed by Mr. Child for motors, batteries and controlling devices, we will first assume 30 tons of coal. This leaves 145,800 lb. available for steam machinery. Without going to the extremes of light construction, this would provide for the development of from 2,500 to 3,000 I. H. P., giving from 2,200 to 2,700 horse power on the shaft. Taking again only 10 tons of coal as corresponding to trial conditions, we should have 190,600 lb. available for steam machinery, which would provide for the development of from 3,000 to 3,800 I. H. P., giving from 2,700 to 3,400 horse power on the shaft. These figures correspond closely to the latest Navy Department designs for torpedo-boats, where, with 150 tons displacement, 3,000 I. H. P. are to be developed on 178,600 lb., giving practically 60 lb. per I. H. P. Merely as a matter of comparison with the electrical equipment it would not be unfair to reduce the coal to the amount necessary for 1 hour at full speed. If short endurance is admissible in

one type of boat it should not be denied the other. This would reduce the coal to about 4 tons, leaving 204,040 lb. for steam machinery, on which from 3,400 to 4,000 I. H. P. could be developed, giving from 3,000 to 3,600 horse power on the shaft. Of course no one would think seriously of a boat with so small a coal supply, but for comparative purposes it serves to show how wide is still the gap between the possibilities with steam and electrical equipment. With the former we readily develop three times the power possible with the latter, even under the best conditions furnished by the automobile batteries, and from six to eight times the amount under the best conditions given by the standard batteries on the American market. On this point it should be said that these batteries are intended for stationary use, and are not designed or built with a particular view to the saving of weight. With the latter point in view, doubtless a lighter type of construction could be developed, and the figures for the French automobile battery reproduced. The durability and adaptability to marine propulsion of such a battery would still be an open question, and only to be settled by the appeal to experience. All this, however, as we have seen above, would still leave the electrically driven torpedo-boat far from a reality.

The subject of cost should also be noted in connection with the general comparison between these two modes of torpedo-boat propulsive equipment. Mr. Child makes the statement that the cost would be about the same in either case. It is hard to find prices which verify this statement. Steam machinery complete may be built for from $20 to $25 per indicated horse power, or from say $22 to $27 per shaft horse power. The electric motors, including switches, controlling devices, etc., will very nearly cover these figures, leaving the first cost of the batteries practically without an offset in the steam equipment.

Recent net quotations on American storage batteries were on the basis of about $9 per 100 ampere hours for a 5-hour discharge. In large quantities we might expect a reduction, but probably not below from $6 to $7 for the same unit. This would correspond to from $24 to $28 per horse power hour on the shaft or from $120 to $140 per horse power on the shaft for the 5-hour discharge. Taking for commercial American cells the possibilities in the present case at about 200 horse power for 5 hours or 1,000 horse power hours, we should have for battery alone say $25,000. Taking the motor as rated at 350 horse power, its cost would be, perhaps, about $7,000, thus giving $32,000 for the electrical equipment. A 350-horse-power steam equipment complete could be provided for from $8,000 to $10,000.

Regarding the cost of energy in storage batteries, it appears that, taking into account the losses incident upon the various transformations through which it is passed, that mechanical energy delivered to the shaft by a motor from a storage battery will cost nearly twice as much in pounds of coal at the steam engine which charges the cells, as it would if delivered direct from the engine to the shaft. That is, for equal amounts of work on the shaft, electrical propulsion will require the initial consumption of nearly twice as much coal as with the steam engine coupled direct to the screw shaft, the two engines concerned being of about equal efficiency.

There are still other questions which may affect the application of electricity to torpedo-boat propulsion, such for example as the need of protecting both cells and motors from salt water, the need of closing in the cells so as to prevent spilling of the acid due to rolling, questions of durability, repairs and renewals, questions relating to the dependence of a boat upon a generating set as a base of supplies for recharging the cells, etc. These are, however, of secondary importance in comparison with the fundamental question of what can be done, granting that all secondary questions are supposed to be favorably answered. The present paper is concerned with this fundamental question rather than with those of secondary importance. All special discussion of torpedo-boat tactics or of the special suitability or otherwise of limited endurance to torpedo-boat service have been also left aside as unnecessary to the main purpose of the paper.

There are, of course, many special advantages connected with electrical propulsion, such as relative noiselessness and freedom from vibration, absence of smoke or flame, safety from disastrous explosion, instantaneous readiness for use so long as charged, etc., and it is to be most strongly regretted that the limitations are of such a character as to render the possibility of availing ourselves of these features dependent upon a reduction in the weight of storage cells which at present seems hopelessly beyond reasonable expectation. When it is realized that the light French automobile cell weighs some three hundred times as much as coal for equal energy stored and some thirty times as much for equal amounts of work at the shaft, it is clearly apparent that so long as these relations hold the storage cell cannot hope to displace coal for marine propulsion, except in those cases where moderate speed and short endurance are not objectionable. To our present-day judgment it would seem that if energy stored in the electrical form is to rival in compactness that stored in coal, it will require a development along some line entirely different from that represented by present-day storage cells.

What developments in these lines the future may hold for us the event alone can determine, and should the day soon come when electricity can be satisfactorily and efficiently employed for the attainment of the highest results in marine propulsion, probably none will be more ready to welcome the change than those who see in its present-day limitations an insuperable bar to its use at the present time.

Alexander Stephen, senior member of the shipbuilding firm of Alexander Stephen & Sons, on the Clyde, died recently, aged 67 years. The Stephen family has long been identified with the industry of shipbuilding in Scotland, the deceased having followed it all his life, learning the practical side of the business in his father's yard. To Mr. Stephen is given the credit for the introduction of the composite system of building ships. Many of the vessels built under his direction performed notable service, the best known on this side perhaps being the Confederate cruiser *Shenandoah*, which previously had been a merchant vessel. The yard got a good deal of unenviable notoriety a number of years ago, due to the overturning of the steamer *Daphne* when she was launched, which resulted in the drowning of a great number of workmen and others who were on the vessel at the time.

PROGRESS OF THE PARSONS STEAM TURBINE FOR MARINE PROPULSION.

In former issues we published a considerable amount of data concerning the Hon. Charles A. Parsons' experimental vessel *Turbinia*, which was in the form of papers read by the inventor before British technical societies. Since the reading of those papers and the consequent world wide announcement of the success of the turbine driven experimental 100 ft. boat, much work has been done by the inventor in the direction of extending the application of the turbine to marine propulsion. A company styled the Parsons Marine Steam Turbine Company was formed late in 1897 for the purpose of taking over the rights and property of the original organization which built and tested the *Turbinia*. The new company, started with a capital stock of $1,250,000, was organized for the purpose of placing the invention on a commercial basis and entering into actual competitive practical work on a large scale. A site containing about 23 acres of land was secured at Wallsend, on the river Tyne, on the northeast coast of England. Suitable machinery for the construction of the turbine engines was purchased, and an extensive use was made of electric motors for power purposes, the generators supplying current being driven by turbines.

The company has now in hand two torpedo boat destroyers of large power and high speed, one, we understand, being for the British Government, and the other for Armstrong, Whitworth & Co. One, if not both, of the vessels is fitted with two separate sets of engines for the port and starboard sides respectively, and four propeller shafts. One each side the outer shaft is driven by a high pressure turbine, and the inner by a low pressure turbine, the inner shaft having also a small reversing turbine connected up. The total power available for going ahead is 10,000 I. H. P., which, on the dimensions, is calculated to give a speed of 35 knots. There is enough power available for reversing to send the boat astern at 16 knots. Condensers are fitted for each set of engines, and the air pumps are driven by small turbines, so that all reciprocating parts are got rid of, together with the probability of annoying vibrations which the usual form of pump would set up. For boiler feed steam pumps of the Weir pattern are fitted. Lubrication of the main bearings is secured by a system of forced oil circulation.

To get this amount of propulsive power upon the displacement of the regular 30 knot destroyer means, of course, a saving of weight somewhere, and in this is pointed out one of the advantages of the turbine method of propulsion. The engines are of less weight though of vastly more power than reciprocating destroyer-engines, and the saving here is made use of in the needed enlargement of the boiler capacity. This amounts to about 12 per cent in size. A gain is also expected in the steam consumption of the turbines as compared with the most economical form of the reciprocating type of engine. There is also a saving in weights of shafting and propellers. In a destroyer of 310 tons displacement it is estimated closely that the saving in machinery weights will permit of an increase of the steam raising capacity to the extent of about 2,000 sq. ft. of boiler heating surface. It is also claimed by the inventor that on account of the absence of heavy reciprocating parts, linkage, etc., in the engines that they can be made with a larger margin of strength and capacity than reciprocating engines.

A comparative statement is made between a destroyer of 320 tons displacement equipped with express water tube boilers and turbine engines of about 12,000 I. H. P. and a destroyer of say 300 tons displacement with express water tube boilers and reciprocating engines of about 6,000 I. H. P., as follows:

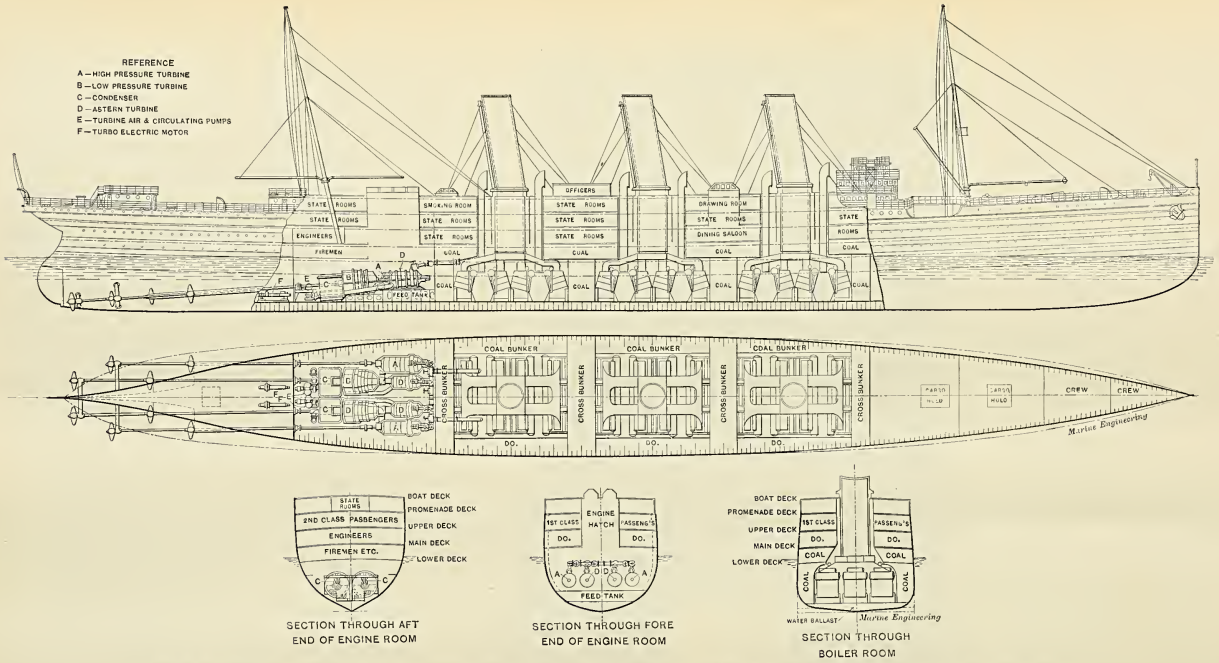
	Turbine Destroyer.	Regular Type.
Boiler room weights with water in boiler	225,680 lb.	174,720 lb.
Engine room weights with auxiliary gear and water in condensers	117,185 lb.	125,440 lb.
Weight of propellers and shafting, etc.	17,304 lb.	22,400 lb.
Totals	360,169 lb.	322,560 lb.

Consequently the weight of machinery of the turbine destroyer figures out 30.01 lb. per indicated horse power, and that of the ordinary type destroyer exactly 53.76 lb. per indicated horse power. The hull of the turbine destroyer can also be made lighter, as the rotary motion of the turbine and absence of vibration make it possible to dispense with the added weights at the after end for structural strength, such as are demanded with the reciprocating form of engine.

It will be remembered that a series of observations were made by Prof. Ewing on the *Turbinia* when she came out, at the request of the owners. The important question of steam consumption, among others, received special attention. The indicator could not, of course, be applied to the turbine form of engine, and so the resistance of the vesel derived from tank experiments was used as a basis for computing the horse power at any speed up to a maximum of 32-knots. An exact record of the amount of feed, etc., used was also kept, and from the data thus secured the steam consumption for all purposes at the 31 knot speed was found to be 28 lb. per propulsive horse power. This, on the basis of 55 per cent of propulsive to indicated horse power, gave a steam consumption of 14 1-2 lb. per indicated horse power, and the coal consumption was rather less than 2 lb. per I. H. P. per hour.

How far these expected results will be reached or surpassed in the vessels under construction remains to be seen. Recent brief telegraphic reports seemed to indicate that the preliminary trials of one of the vessels were not satisfactory, but this is no criterion. Some detail of construction or equipment which might have no bearing whatever upon the efficiency of the machinery could, reasonably, be responsible for delay or disappointment.

No doubt the success of boats of the character of those now in hand would greatly aid in a more widespread adoption of the turbine form of propulsion. It is claimed for this type of engine that with larger engines, such as would be needed for full powered seagoing vessels, the conditions for the highest economy in steam with a minimum of weight, could be more easily met. While as yet no orders for the equipment of large mercantile vessels have been booked by the company, some work has been done in the direction of design. Plans have been prepared for an installation in a proposed ocean liner giving a total of 38,000 I. H.



PLANS OF PROPOSED TYPE OF OCEAN LINER FITTED WITH WATER TUBE BOILERS AND PARSONS TURBINE ENGINES—ESTIMATED SPEED, 26 KNOTS.
Plans originally drawn for Engineering, London.

P. and an estimate rate of sea speed of 26 knots. The proposed vessel would have these dimensions: Length between perpendiculars, 600 ft.; beam, extreme, 63 ft. 3 in.; depth, molded, 42 ft.; draught to bottom of keel, 28 ft.; displacement, 18,000 tons; total bunker capacity, 5,000 tons. Making a comparison as to machinery weights between the proposed vessel and a liner of similar dimensions with reciprocating engines of about 26,000 I. H. P. and Scotch boilers, the result would be:

	Turbine Liner Water Tube Boilers.	Regular Type Scotch Boilers.
Boiler-room weights with water in boilers.....	1,364 tons	2,225 tons
Engine-room weights with auxillary gear and water in condensers.....	822 tons	1,220 tons
Shaft and propellers.....	210 tons	305 tons
Totals	2,396 tons	3,750 tons

The machinery weights of the turbine liner figure out 141 lb. per indicated horse power, and those for the regular type liner 323 lb. per indicated horse power. The comparative table shows a saving of 1,354 tons in the machinery weights for the turbine driven vessel over that with reciprocating engines on the same displacement, but the larger portion of this is to be credited to the water tube boilers. In the engine-room weights taken alone the difference in weight is almost 500 tons. Were less speed required and the turbine

liner powered to the extent only of the liner fitted with reciprocating engines, the saving in machinery weights would be very large and add greatly to the earning capacity of the vessel.

The advantages which, it is claimed, would result from the substitution of steam turbine machinery in a liner would be:

(1) A reduction of total engine-room weight to about one-half that of ordinary engines. (2) A small reduction in steam consumption per indicated horse-power. (3) Complete freedom from all vibration from the main engines, and a great reduction of vibration from the screw propellers. (4) A smaller engine-room staff to deal with the simpler and lighter engines and shafting. (5) Less consumption of oil and stores.

Commenting on these claims, *Engineering*, London (to which we are indebted for many of the foregoing particulars) remarks that the perfect balancing of the engines permits of very light engine-room foundations, and obviates that stress or strain on the hull, which is produced by the reciprocating forces of ordinary engines. The absence of lubricant from the internal parts of the engines is a benefit to the condensers and boilers. It diminishes the cost of cleaning and repairs, and enables very high boiler pressures to be used without risk. It is proposed that the steam should be reheated between the high and low pressure cylinders by coils of steel tubes containing steam at boiler pressure. Compound feed heaters, supplied with steam drawn from several points in the expansion in the main engines, would raise the temperature of the feed to above 212 deg. Fahr. The exhaust from the auxiliaries would also be added to one or more of the heaters. The trials of the *Turbinia* showed a total consumption of steam for all purposes of 14 1-2 lbs. per indicated horse power of the main engines at 31 knots, but in a liner the consumption would undoubtedly be less owing to the larger size and more perfect expansion, the higher boiler pressure, better vacuum and other minor details. Smaller size of the screw propellers diminishes vibration due to uneven action of the blades in the stream lines of the vessel. Smaller diameter also permits of some 8 ft. more immersion above the tips of the blades, so that the evils of screw racing in heavy weather will be mitigated, and the vessel better able to keep her speed.

With the steam turbine the turning moment on the shafting is absolutely uniform, and these engines have much more momentum (or flywheel inertia) than ordinary engines. They will, therefore, not gather speed so quickly should the screws top the surface, and the engine governor will have more time to come into action and prevent racing. The shafting is only about one-half the usual diameter for equal total indicated horse power, and can, therefore, be much more easily dealt with by the staff, and spare parts more easily carried. The four shafts are an additional safety against total break down of the engines; and should one of the engines break down the other three are not interfered with, as they are quite independent excepting as regards the steam supply, which is controlled by valves. The small headroom required for the turbine engines and their quiet working permits of cabins being placed over part of the engine-room.

In the accompanying engravings plans of the proposed liner can be read.

SHIPBUILDING PLANT OF WOLFF & ZWICKER, AT PORTLAND, ORE., ON PACIFIC COAST.*

The engineering and shipbuilding works of Wolff & Zwicker, lately brought to public notice in connection with the construction of torpedo boats for the U. S. Government, is situated at Portland, Ore., on the east bank of the Willamette River, eight miles from its confluence with the Columbia, and about ninety miles from the mouth of the latter river. The works originally were on the west side of the river, where a general machine business was carried on. In 1892 they were moved to the present location, on the water front, but shipbuilding was not taken up till about four years ago, when contracts were secured for building the torpedo boats *Fox* and *Davis*. These contracts were successfully fulfilled, and the progress made in this branch of work since then has been quite remarkable. And while the plant does not include everything to be desired, a very good equipment for moderate sized work has been built up.

Although some distance from salt water, the location is good, as these rivers are navigable for large vessels as far as Portland, and beyond, the Willamette (at Portland) is a quarter of a mile wide, and deep enough to float the largest ships. The current is very slow at ordinary stages of the water, as the river after tumbling over the great falls at Oregon City, twelve miles away, is much wider and deeper than above them.

Both wooden and steel ships are constructed in the yard, the former being preferable in some respects for river traffic, of which there is a great deal on these large rivers. There is an abundance of fine ship timber near by, and a steam saw mill, where it can be cut from the log, forms part of the equipment.

The works are quite complete in themselves, consisting of machine, pattern, boiler, blacksmith, and copper shops, foundry and shipyard. There is also a well stocked store room, the distance from manufacturing centers making this a necessity.

In the illustrations there is given a partial view of the shops and yard. Small craft, such as the torpedo boats before mentioned, are constructed on the partially covered ways, which can be seen running along the side of the shops. The bending floors are under the same roof as the boiler shop. The larger engraving shows half the machine shop to the left, and the foundry is hidden by the machine shop. It also shows the piling now being driven, to support ways for building large vessels. The smaller view was taken from the bridge seen in the larger picture, and looking down the Willamette, showing the U. S. torpedo boat destroyer *Goldsborough*, now in course of construction, receiving her Thornycroft boilers. Work need not be transported far, as everything is close to the water front. The shears on the dock can handle 50 tons. The legs are of wood (Douglass fir); the foot of the inner leg is movable, and operated by a power driven screw, so that the head of the shears may be swung out over a vessel, or drawn in over the dock. It does its work admirably, and the legs give an idea of the fine spars to be had in this section.

The machine shop employs sixty men at present, and while not fitted with very large tools, can handle some

* By our own special correspondent.

good sized work, as shown by some large gate valves just completed. These valves are for an 84-in. water main and weigh fifteen tons when completed. The facilities for handling work in the shop are not as good as might be, mostly owing to the fact that the shop has outgrown the work it was originally intended for. In the shop stand the engines for the *Goldsborough* nearly completed. The workmanship and finish on these engines are certainly first class. The shop is driven by electricity, from Oregon City falls, but has steam power also in case of an emergency. It is equipped with compressed air and hydraulic systems, for the operation of portable tools, hydraulic presses, etc.

The foundry employs forty men. It has two cupolas and can cast twenty tons a day. The handling is done with large hand power jib cranes, with which the shop is well equipped. There is also a brass foundry which can cast 3,000 lbs. at one pouring. The pattern shop employs twenty men, and is well equipped with power tools. There is also a good stock of standard patterns, the greater portion of which is for other than marine work, such as mining and mill work, and which forms not an inconsiderable portion of the product.

The boiler shop is very well fitted out. There is a good assortment of medium sized vertical rolls, and one large set of horizontal rolls, 16 1-2 ft. between housings, for heavy plate. There is a good assortment also of punches, shears, bevel shears and gang punches, the largest machine being able to punch a 6-in. hole in 3-4 in. plate. There is also a small plate planer, a small hydraulic bending machine and a number of portable hydraulic riveters and other portable tools. A large hydraulic riveter, having a gap 8 1-2 ft., and capable of driving 1 1-2 in. rivets, is now being erected, which, with the five small hydraulic riveters already on hand, makes this portion of the plant quite complete. A pneumatic system operates the portable tools for chipping and calking. The yard is fitted out with the necessary furnaces and bending floor.

The blacksmith shop has eight fires, and is equipped with good bolt headers for small work, and a large machine operated by hydraulic power for bolts up to 3 in. dia. There is also at present a 600-lb. steam hammer, a larger one being a necessary and contemplated improvement. Altogether about 300 men are now employed, the works being very busy.

VIEWS OF SHIPYARD OF WOLFF & ZWICKER, AT PORTLAND, OREGON.

Among other vessels built by this firm might be mentioned the *Sampson*, a tug boat 125 ft. long, the U. S. torpedo boats *Davis* and *Fox*, and two steel lightships for the U. S. Government. One of these ships is stationed on the Columbia River bar, the other near the entrance to San Francisco bay.

The officers of the company are: President, F. Wolff; Vice-president, J. E. Wolff, Secretary, F. E. Zimmerman. The Superintendent and Chief Designer is F. A. Ballin, formerly with the Detroit Dry Dock Co.

STERN WHEEL RIVER STEAMBOAT FOR THE KLONDIKE TRADE.

Gold discoveries in the Klondike region called into existence a large number of vessels for river service, many of which were wrecked or lost, while others put in use successfully made money for their owners. An interesting boat of this latter class is the *Willie Irving*, a stern wheel steamer plying on the upper Yukon River between Dawson City and White Horse Rapids, the head of navigation. This vessel is of the following dimensions: Length of hull, 80 ft.; beam, 20 ft.; depth of hold, 3 ft., and draught ready for load, 12 in.

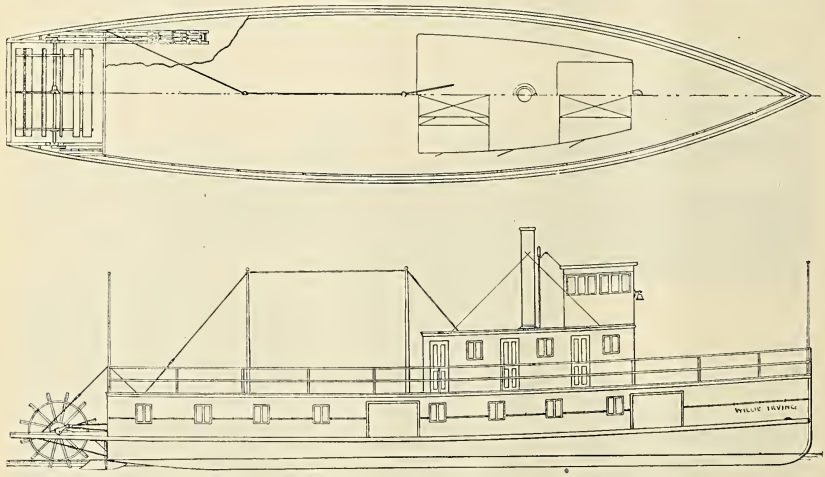
She was built by Joseph Supple, at Portland, Ore., about a year ago, and the entire outfit of driving machinery and accessories was especially designed and built by the Marine Iron Works, Chicago. Boat and machinery were shipped in knock-down shape to Skagway in such form that it was safely transported over the White Pass, and the boat re-erected and launched at Lake Bennett. Her owner, Capt. E. W. Spencer, of Portland, Ore., after thoroughly investigating the dangers of Miles Canyon and White Horse Rapids, decided to take her to Dawson. He was warned that it would mean destruction for the boat and death for the crew, but he had navigated on swift waters before and felt sure of himself and his boat. He knew there was sufficient depth of water, and that safety depended upon maintaining perfect control of the craft. After a few short runs on Lake Bennett and tributary waters to test her machinery and steering qualities, a start was made down the river with a load of passengers and freight for Dawson. The exciting run was made safely without causing a mishap, and he arrived at Dawson with passengers and cargo in fine condition. The receipts from freight and fares more than equalled the entire cost of boat and supplies.

At Dawson City Capt. Spencer was offered a price for the steamboat, and as it represented a clear and quick profit on his enterprise he accepted. Her new owner made ten trips between Dawson and White Horse Rapids during four months last season with receipts of $127,668.00—an unusual amount for an 80 ft. steamer, even for river service, in a land of high prices.

The boat proved to be a large carrier, stiff and speedy, and a close and easy handler in swift water. Her average time on the up river trip was 7 days.

When it is considered that no piece or part of boat or machinery or outfit was so heavy that two men could not transport it over White Pass, or any timber or section over 24 ft. long, it will be apparent that the construction was peculiar.

The upper works consisted of a single cabin the full length from the stem to stern, with pilot house and texas. The cabin floor or main deck was carried 20 in. below the guard, this being necessary on account of the variable and violent winds that cause much trouble to navigators on Lake Bennett and tributary waters.



STERNWHEEL STEAM BOAT WILLIE IRVING, FOR YUKON RIVER TRADE.

Some of the details of construction follow: Keel, 1 1-2 in. by 8 in., in four pieces, butted between frames: frames, 2 1-2 in. by 2 1-2 in., bent oak, set at 20 in. centers—when shipped these frames were held to form by wires instead of cleats, to lighten weight and lie together more compactly: Floors of Oregon pine, 2 1-2 in. by 2 1-2 in., bolted to the frames, with four screw bolts in each frame: Center keelson of three 1 1-2 in. by 8 in. timbers set on edge and bolted through and through, making it as stiff as a solid stick: Side keelson of two 1 1-4 in. by 10 in. pieces set on edge, and bolted through like center keelson: Center keelson fastened with two bolts through each floor stick: Cylinder keelsons four pieces 4 in. by 6 in. by 20 ft. long: Stem of oak re-enforced with a knee of Oregon pine: Clamps and also sheer 1 in. by 8 in.

Oregon pine: Shelf 2 1-2 in. by 2 1-2 in.: Bilge strakes 2 1-2 in. by 5 in.: Cross keelsons 2 1-2 in. by 2 1-2 in. every 10 ft., set on top of fore and aft keelsons, with knee at each end bolted to bilge strake, clamp sheer and frame: Deck placed on a level with these cross keelsons; decking of 1 in. lumber laid athwartships, resting on stringers laid on the fore and aft keelsons: Bottom planking 1 1-2 in. by 12 in.: Side planking 1 in. by 5 in.: Transom 2 in. by 12 in.: Knees used to strengthen the frame and planking all butted between frames.

The vessel is fitted with three balanced rudders. The entire skeleton of the hull was put up with carriage bolts when erecting it at the Portland boat yard. The holes were all drilled full size, but the bolts used were 1-16 in. smaller in diameter than those put in at final erection, thus avoiding undue strain to the lumber and facilitating taking down.

The total amount of lumber used in the completed boat was 8,800 ft., being principally choice Oregon pine, and the results have proven that it was all put where it did the most good.

The engines were two 7 in. by 28 in. double ported, balanced piston valve, direct acting, stern wheel engines of the regular Marine Iron Works type. They were installed with their auxiliary bearings built on to the steel wheel and engine beams. When constructed they were fitted and lined up complete in the builder's shop and run by steam pressure under approximately the same conditions as when installed in the boat. The wheel was 9 ft. 9 in. dia., with buckets 9 ft. long and 13 in. wide. There were twelve of these, each 1 1-2 in. thick. With 200 lbs. steam pressure and 36 engine revolutions per minute the boat attained a speed of about 12 miles per hour. The steel stern wheel shaft was 3 3-4 in. dia., in two sections, the steel coupling forming also the central paddle wheel flange.

Steam was raised in a Roberts water-tube boiler which was built for 250 lbs. maximum pressure per square inch. The boiler was fitted with an extra deep fire box for burning wood. Auxiliaries included a "Marine" outside packed plunger steam boiler feed pump, such as is supplied for use with gritty water. Also injector, test pump, sea cocks, bilge syphons, and an independent feed water heater, all arranged with special reference to the service for which the *Willie Irving* was built.

Another steamer (the *Scotia*) practically a duplicate of the *Willie Irving* has just been completed for Capt. Spencer by the Supple Shipyard, Portland, Ore., and Marine Iron Works, Chicago; the machinery consisting of a pair of 7 1-2 in. by 28 in. double ported balanced piston valve engines built onto steel wheel and engine beams. This new boat equals, and perhaps exceeds in general efficiency and speed the *Willie Irving*, and though she is a trifle heavier craft, her machinery represents an increase of about 18 per cent in power. Her actual total weight, inclusive of cabin and upper works, is 59,000 lbs., being just 12,000 lbs. heavier than the *Willie Irving*, the hull measurements of the two boats being the same. The *Scotia's* paddle wheel is 10 ft. 3 in. dia. outside of the buckets and 9 ft. 4 in. long. Each of the twelve buckets is 12 in. wide by 1 1-2 in. thick.

METHOD OF OPERATING SEACHLIGHTS MORE EFFICIENTLY BY USE OF DYNAMOTERS.

BY ALTON D. ADAMS.

The increasing use of electric light and power on board ships of both the war and merchant type renders more important the question of the electric pressure at the dynamos and in the wiring. When the largest electric ship plants included only a searchlight and a few incandescent lamps, the first cost, power to operate and attendant losses were all small matters, and the pressure of distribution was naturally fixed at only a moderate amount above that necessary for the searchlight, which was the most important device to be served and the largest consumer of power. These early conditions have now been changed so that the searchlight, while still of the utmost importance in its field, consumes but a small part of the electric energy generated in many ship plants, and is a mere fraction of the total cost. On large ships electric plants are now operated, each of several hundred horse-power capacity, and in view of the extending use of electric motors for auxiliary power on both war and merchant ships, equipments of more than 1,000 horse-power capacity may be expected in the future.

These changed conditions make an increase of the electric pressure of ship plants from 80 to 110 volts, and in some cases to 220 volts, desirable, not only because of the losses in resistance coils used with searchlights, but to a greater extent because of the material reduction in first cost, the increase in efficiency, decrease in weight, and better operative conditions made possible in other parts of the electric plant by the higher pressures. Several tons of insulated electric wires are required in a ship plant of medium size, at 80 volts pressure, and the cost of these wires will vary from about $800 to $1,500 per ton, according to size and quality. The loss of pressure in electric wires between the dynamos and the lamps or motors should be kept as small as practical, because as much variation of pressure and many times more change in candle power will take place at the lamps as there is loss in the wiring between no load and full load. This variation in volts at lamp terminals is to be avoided, not only because of the greater resultant variation in light, but also because the life of the lamp is much shortened by such changes.

While it is thus desirable to have the loss of pressure small between dynamos and lamps, the fact that the weight of wire increases in the same ratio that the last pressure decreases is a strong motive to proportion circuits for greater loss than is desirable. Now, with a given load and fixed energy loss, which corresponds to a constant per cent of pressure loss in wiring, the weight of copper to wire a certain ship varies as the square of the volts at which the system is operated. Suppose then that to wire a given ship with a certain percentage of loss in conductors, 3 3-4 tons of copper are required for an 80-volt system, then by using the 110-volt system less than 2 tons of copper will be necessary, while with the adoption of the 220-volt system the weight would be reduced to about 1-2 ton. These ratios being subject to a slight variation on account of the probable differences of the weight of insulation, which does not vary in the same ratio as the size of the conductor.

A practical result of this law is to encourage a small drop in pressure between dynamo and lamps when the

higher pressures are used. Thus, in the case just cited, a drop of 4 per cent. in pressure might well be permitted at full load in the wiring for the 80-volt system. Were 220 volts E. M. F. selected, the drop should be reduced to not more than 2 per cent, and even then a saving of about three-fourths the former weight of copper would be effected. The fact that the areas of brush, commutator and switch contacts decrease in about the same ratio that the operating pressure increase for a given capacity of plant is another argument for the higher voltage, especially in large ships, where auxiliary motors are coming into use for many purposes. Opposed to these higher pressures is the searchlight, capable of using only about 50 volts pressure at its terminals, and subject to some disadvantages if operated from pressures greatly beyond present practice, by means of interposed resistances. Aside from the matter of unsatisfactory operation on comparatively high potential circuits, the energy lost in the necessary resistance is to be considered.

With large searchlights taking 100 amperes, as in use on the U. S. battleship *Iowa*, for example, this loss may be considerable. Of the energy drawn from the circuit the searchlight only uses $50 \div 80 = 63$ per cent with the 80-volt system; $50 \div 110 = 45$ per cent with the 110-volt system, and $50 \div 220 = 23$ per cent with the 220-volt system. The remainder—37, 55 and 77 per cent, respectively—of the energy in the searchlight circuit is wasted in idle resistance coils. As a large ship may have several of these lamps in use at one time (the *Iowa* is equipped with four), it is evident that some means other than the present must be adopted before the higher voltages will become common in ship systems. Happily, means are not wanting whereby searchlamps may be operated in an economical and satisfactory manner from systems using any of the above or even higher electric pressures.

To render the searchlight independent of the voltage of the system from which the power for operation is drawn, some device must be employed to take electric energy at the available pressure and deliver it with small loss to the lamp at a pressure of about 50 volts. This can be accomplished by either the motor-dynamo or the dynamotor. The motor-dynamo consists of an electric motor and a dynamo, mechanically connected, and frequently constructed on the same base, with a common armature shaft and bearings, though the armature cores and armature coils, also the magnet cores and coils, must be distinct. The motor windings of the combination take current from the supply mains at any desired pressure, and the dynamo windings deliver current at any other pressure required.

Pressure delivered by the dynamo windings can be regulated with changes in load so as to increase, decrease or remain constant, by changing the exciting power of the dynamo, magnet coils, either through compounding or the use of a rheostat in the shunt. Where it is desired to operate several searchlights from one auxiliary machine the motor-dynamo will, perhaps, be found best suited to the purpose, as the pressure of the dynamo coils may be held constant at a point just high enough to permit regulation by a resistance coil in the circuit of each lamp, say 60 to 70 volts, no matter whether all the searchlights are connected at one time or not.

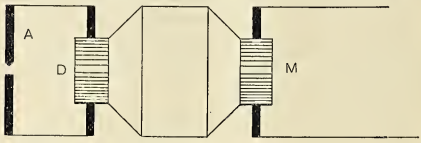


FIG. 1.

Taking the efficiency of the motor-dynamo at 75 per cent., and allowing the dynamo coils to work at a pressure of 60 volts, the lamps will be able to use $(50 \div 60) \times .75 = 62$ per cent of the energy taken from the line, or almost exactly the same as in the present system of working searchlights from 80-volt systems.

This method, with one large motor-dynamo to operate all searchlights, will permit the use of any desired pressure in electric ship plants, and give the same efficiency as is now had with the 80-volt system. It is desirable, however, to increase this efficiency, and the necessary means are at hand—the dynamotor.

A dynamotor is an electric machine with one armature core and one field magnet, but with two independent windings on the armature and two commutators. One winding of the armature takes current from any available supply and runs the machine as a motor, while the other winding generates the pressure and current for which it was designed. As both windings work on one armature core in the same field, a constant pressure cannot be maintained at the dynamo terminals if the load increases, but this property is well suited to searchlight operation, as a constant current, but not a constant pressure, is required in the lamp. By the use of a dynamotor for each searchlight the resistances in series with

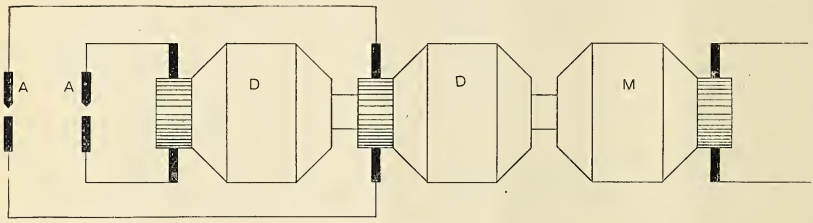


FIG. 2.

the lamp may be eliminated and the dynamo winding of the machine designed for 50 volts, the pressure necessary for the lamp under normal conditions of the arc. Small dynamotors corresponding in capacity to a medium or large searchlight can be had with 80 per cent. efficiency, and as no energy is wasted in resistances, the lamp in this case uses 80 per cent. of the energy taken from the line, no matter at what pressure the plant is operated, or about 80 — 63 = 17 per cent. more than it is possible to obtain with a low pressure of 80 volts and without a dynamotor. As the dynamotor has but one field magnet, armature coils and set of magnet coils, its efficiency in small sizes will usually be from 5 to 10 per cent higher than that of equivalent motor-dynamos, whose use as above is therefore to be preferred when an independent machine is desired for each searchlight. Where it is desired to provide for two searchlights in one machine, however, nearly equal results can be had with a motor-dynamo consisting of one motor and two dynamos, each dynamo operating but one lamp. So long as the dynamo end of a motor-dynamo, or the dynamo winding on the armature of a dynamotor, is designed to operate but one searchlight, the use of resistances in series with each lamp is unnecessary, as the dynamo will regulate automatically, lowering the E. M. F. of the lamp circuit when the carbons move close together and the current increases. If more than one searchlight is to be operated in multiple, the E. M. F. at the dynamo terminals must be kept nearly constant, as it cannot follow the variations of all the lamps. These variations must be provided for by a resistance in series with each lamp, as in the first arrangement suggested, where one motor-dynamo operates several lamps. Two or more searchlights might be operated in series by one dynamo of motor-dynamo set, so designed as to regulate for constant current, whether one or all the lamps are in use, but the special construction necessary to such regulation would probably not be warranted by the circumstances.

As resistances in series with lamps change electric energy into useless heat, it seems better to avoid their use and to provide a dynamo of a motor-dynamo set, or a dynamotor for each searchlight to be operated, except perhaps in the case of the smallest sizes.

Fig. 1 shows the connections of a dynamotor armature, the dynamo commutator, *D*, being connected directly to the searchlight, and the motor commutator, *M*, to the supply line of any desired pressure. Fig. 2 shows the connections of a motor-dynamo set, with two dynamos driven by one motor; the two dynamo commutators and armatures, *D*, are each connected with a searchlight, and the motor armature, *M*, with the supply mains. Motor-dynamos and dynamotors effect so large a saving and are so readily applied to the above purpose that their extended use with searchlights on large ship plants seems certain to come with and facilitate the necessary application of higher pressures.

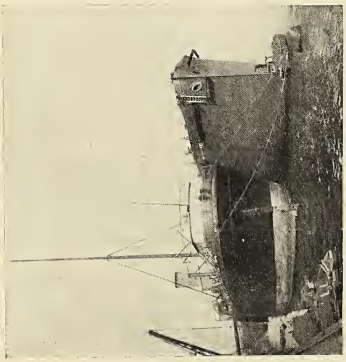
The British battleship *London*, 15,000 tons displacement, was launched at Portsmouth dockyard recently, where she had been laid down December, 1898. Her armament will include four 12 in. breech loaders, twelve 6 in. rapid fire guns, and nearly forty rapid fire guns ranging in size from 3 pounders downward.

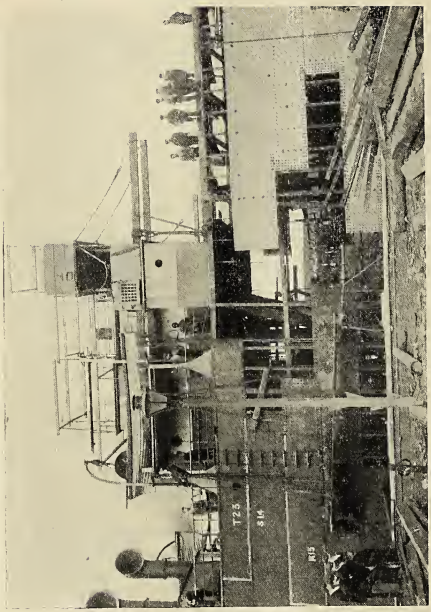
Reconstruction of S. S. Milwaukee.

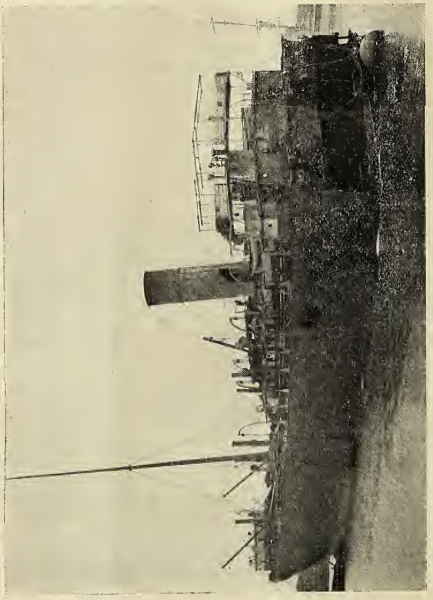
The reconstruction of the British steamship *Milwaukee* in the American trade is a remarkable and extremely interesting engineering feat. Our subscribers will recall a view of this vessel, or rather of the after portion of it, which we published, together with an account of the mishap which befell the vessel several months ago. While on a voyage from the northeast coast of England to New Orleans in ballast the vessel went on the rocks near Peterhead, on the coast of Aberdeenshire, Scotland. The salvage company to which was intrusted the job of saving the vessel, if possible, found that her fore part was so tightly wedged in the rocks that to float her was impossible. As the after part of the vessel was uninjured it was decided to cut this away forward of the engine room bulkhead and tow the uninjured portion to the builders' yard, located on the River Tyne. More than 500 lbs. of dynamite was used for the purpose of separating the ends, and by placing small charges at suitable intervals around the hull at the desired point the after end was freed without mishap or injury. Then the end of the ship was towed bulkhead foremost from the scene of the wreck to the Tyne and it remained staunch. Probably the most extraordinary feature of this trip was the fact that the engines of the vessel were used to assist the tugs. When the after end reached the Tyne safely the construction of a new forward portion of the vessel was at once begun. The bow was launched and the two ends were then floated together (as shown in the engraving) until placed in dry dock and united into a complete vessel. The work of joining the ends was accomplished without difficulty, and after the job was completed and the vessel painted it was not possible to tell where the old work ended and the new begun. So carefully was the reconstruction planned and carried out that the chief dimensions of the vessel are not changed, and there is only six tons difference in the gross tonnage of the original vessel and the present S. S. *Milwaukee*. The *Milwaukee* was built by C. S. Swan & Hunter, at Wallsend-on-Tyne, in January, 1897, for Elder, Dempster & Co., of Liverpool, and her chief dimensions are: Length 470 ft., beam 56 ft. and depth moulded 34 ft. 9 in. and tonnage about 7,317 tons gross.

The salvage was effected under the superintendence of Captain Batchelor of the Liverpool Salvage Association, assisted by Captain Evans, the Marine Superintendent for the owners. Through the courtesy of the owners we are able to present to our readers, on the two following pages, reproductions of photographs showing the salved portion of the vessel, the work of reconstruction, and the completed vessel.

It is rather unusual for a steamship to be moved on the water and yet not in the water, but this feat was performed recently in New York harbor in the case of the steamship *Richmond*, of the Old Dominion line. The vessel was in a balance floating dry dock in Erie Basin, and the dock was towed a distance of about a half-mile to a new anchorage. The *Richmond* is a screw steamer of the following dimensions: Length, 210 ft.; beam, 33 ft.; depth, 21 ft. 6 in.; gross tonnage, 1,102 tons. The balance dock has a capacity of 3,500 tons.

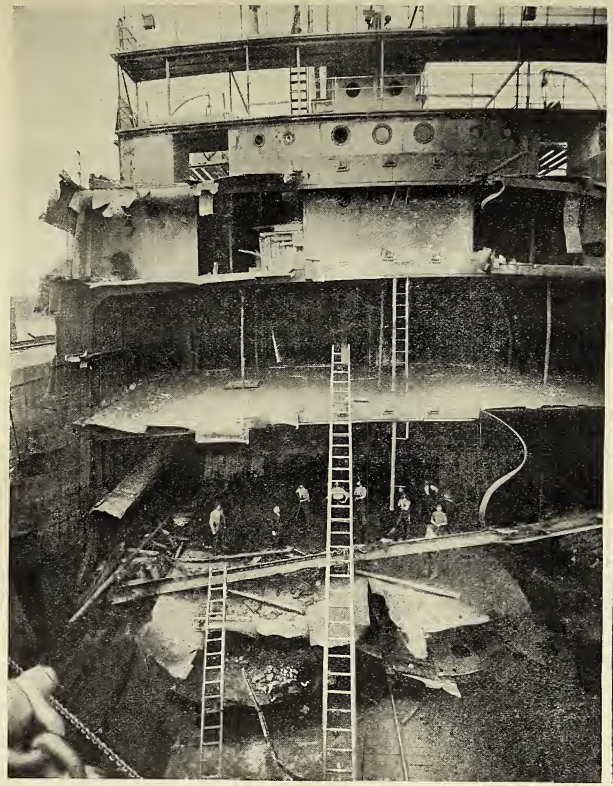




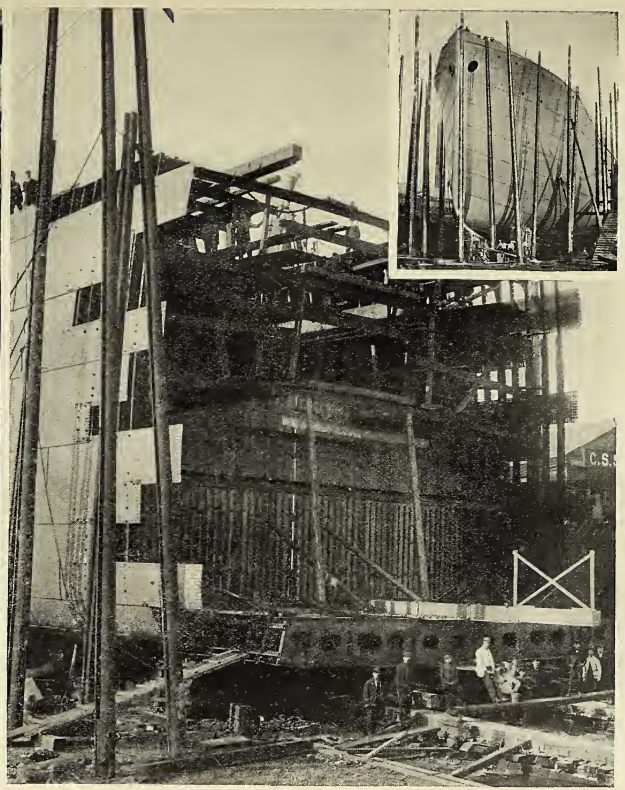


Original stern and new bow nearing in same direction.
Stbrd. portion on it's arrival in river Tyne.
S. S. Milwaukee as originally built and practically as reconstructed.
Original stern and new bow in place ready for the connecting plates.

ORIGINAL PHOTOGRAPHS SHOWING RECONSTRUCTION OF S. S. MILWAUKEE, BY COURTESY OF C. S. SWAN & HUNTER, SHIPBUILDERS, WALLSEND-ON-TYNE, ENGLAND.



Salved portions in dry dock, showing damage done by dynamite used in severing the two portions.



Two views of the new bow on the stocks ready for launching.

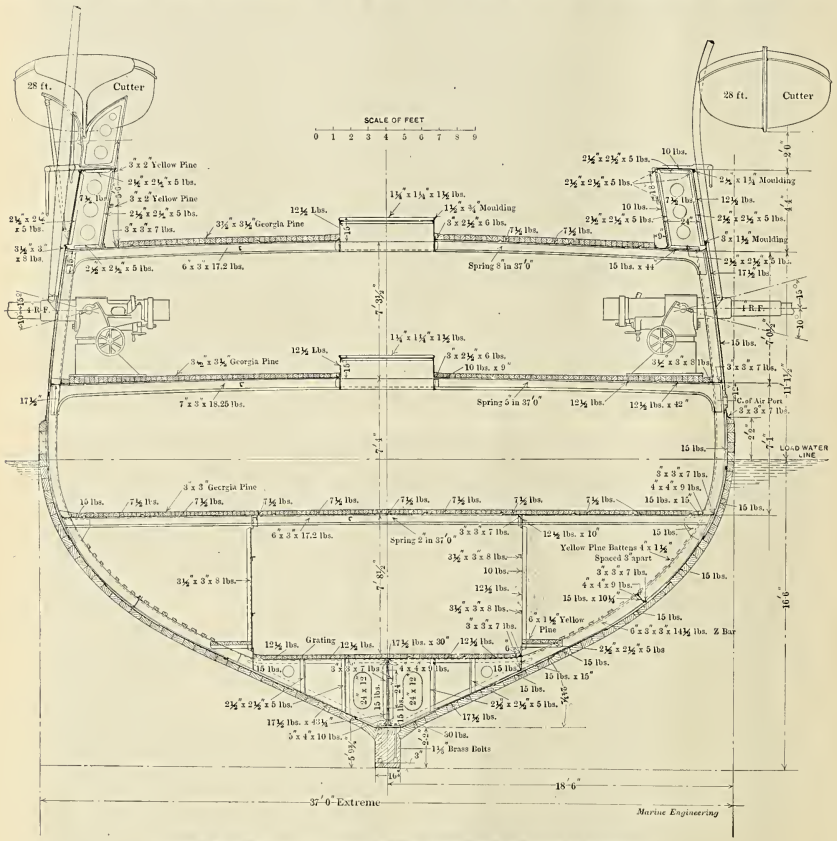
ORIGINAL PHOTOGRAPHS SHOWING RECONSTRUCTION OF S. S. MILWAUKEE, BY COURTESY OF C. S. SWAN & HUNTER, SHIPBUILDERS, WALLSEND-ON-TYNE, ENGLAND.

CONSTRUCTION AND EQUIPMENT OF THE U. S. NAVAL ACADEMY PRACTICE SHIP CHESAPEAKE.

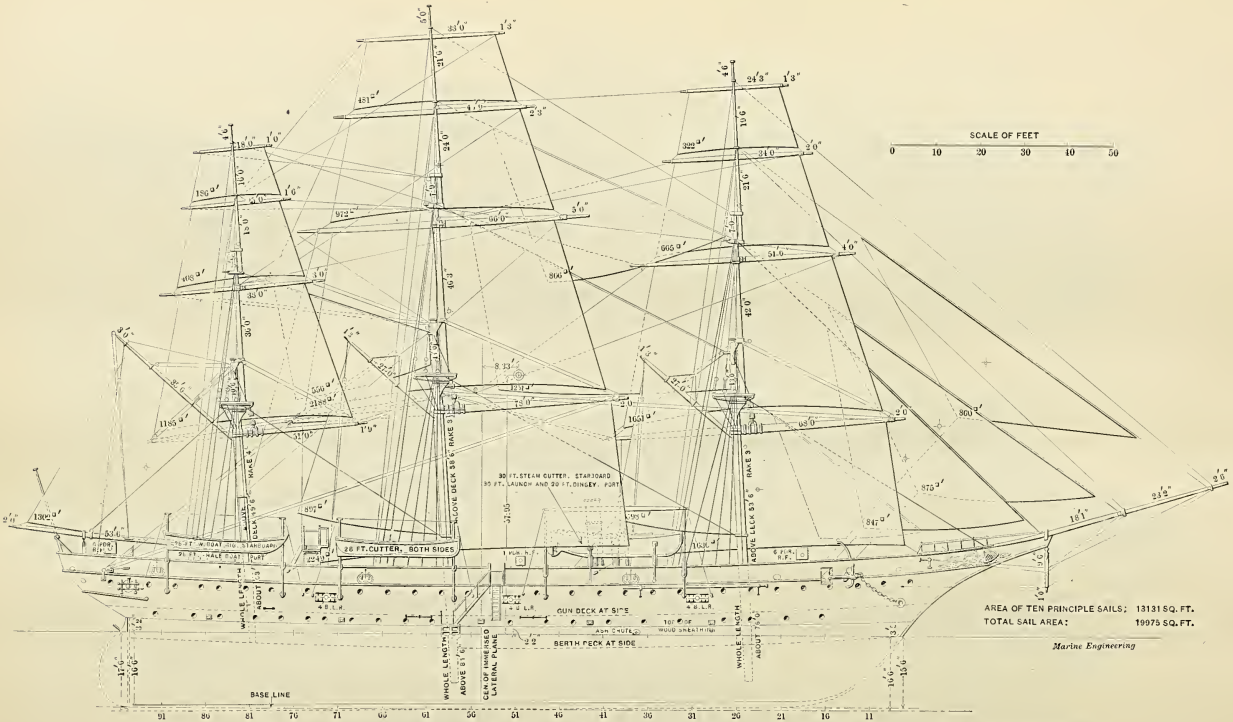
For many years the cadets of the U. S. Naval Academy at Annapolis have been compelled to make practice cruises in old vessels fitted temporarily for this purpose, but in reality unfit for the special purposes of training. In 1897, however, Congress took action looking toward the construction of a vessel exclusively for this use. The result is the *Chesapeake*, built by the Bath Iron Works and now fitting out at the Charleston Navy Yard, Boston, Mass. Under the advice of the naval officers immediately concerned, at the time, a sailing vessel was decided upon. We do not propose in this article to discuss the advisability of adopting an obsolete type of vessel for the purpose, but simply to describe her construction and arrangements. These and her battery comprise the modern features of the vessel.

Designs for the *Chesapeake* were prepared by the Naval Bureau of Construction and Repair, under the direction of the Chief Constructor, Philip Hichborn. She is the first sheathed vessel to be built in this country and the only sailing vessel that has been added to the Navy in over thirty years.

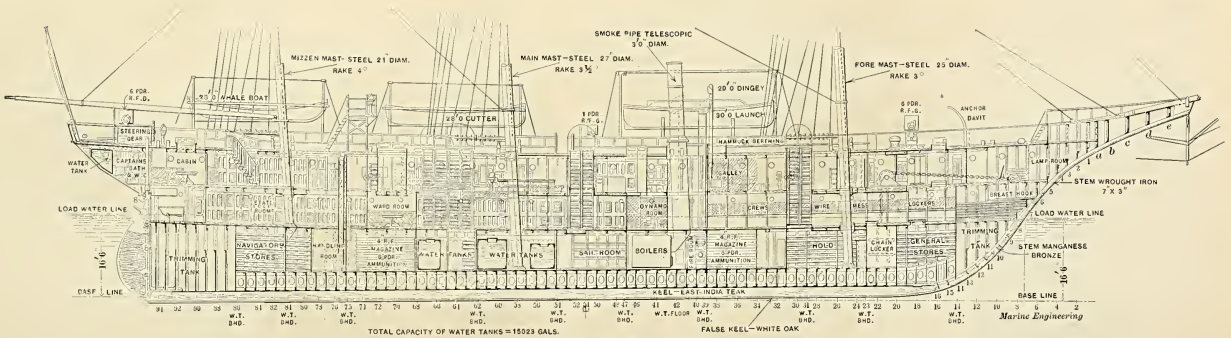
The original appropriation for the vessel made by Congress in 1897 was unfortunately confused. After deciding that a full rigged sailing ship was the proper type of training vessel for the cadets, the wording of the bill was such as to include propulsion by both sail and steam, although the estimate in the hands of the committee did not cover such a design. In amending the bill to exclude steam propulsion a great error was committed, as the appropriation was reduced to but $125,000, or one-half the amount required. The design


28 ft. Cutter
SCALE OF FEET
0 1 2 3 4 5 6 7 8 9
3" x 2" Yellow Pine
2½" x 2½" x 5 lbs.
7½ lbs.
3" x 2" Yellow Pine
3" x 3" x 7 lbs.
12½ Lbs.
3½" x 3½" Georgia Pine
2½" x 2½" x 5 lbs.
6" x 3" x 17.2 lbs.
1¼" x 1¼" x 1½ lbs.
1½" x 3¼" Moulding
3" x 2½" x 6 lbs.
Spring 8 in 37' 0"
15 lbs. x 44"
10 lbs.
2½" x 1¼ Moulding
3 x 1½" Moulding
17½ lbs.
+ R.F.
3½" x 3" x 8 lbs.
7" x 3" x 18.25 lbs.
10 lbs. x 9"
Spring 5 in 37' 0"
12½ lbs. x 42"
C. of Air Port
3" x 3" x 7 lbs.
LOAD WATER LINE
15 lbs.
3" x 3" x 7 lbs.
4" x 4" x 9 lbs.
15 lbs. x 15"
Spring 2 in 37' 0"
12½ lbs. x 10"
Yellow Pine Battens 4" x 1½" Spaced 3" apart
3" x 3" x 8 lbs.
10 lbs.
12½ lbs.
15 lbs. x 10½"
6" x 1½" Yellow Pine
6" x 3" x 14½ lbs. Z Bar
Grating
12½ lbs. x 30"
15 lbs. x 15"
2½" x 2½" x 5 lbs
17½ lbs. x 43½"
5" x 4" x 10 lbs.
50 lbs.
1½" Brass Bolts
37' 0" Extreme
18' 6"
Marine Engineering

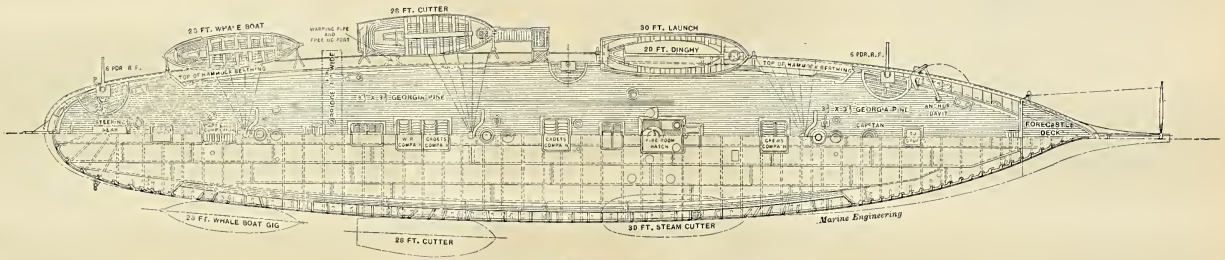
CROSS SECTION OF U. S. PRACTICE SHIP CHESAPEAKE FOR NAVAL ACADEMY.


SCALE OF FEET
0 10 20 30 40 50
AREA OF TEN PRINCIPLE SAILS; 13131 SQ. FT.
TOTAL SAIL AREA: 19975 SQ. FT.
Marine Engineering
26 FT. CUTTER, BOTH SIDES
30 FT. STEAM CUTTER, STARBOARD
35 FT. LAUNCH AND 30 FT. DINGEY, PORT
GUN DECK AT SIDE
BERTH DECK AT SIDE
BASE LINE

SAIL PLAN OF THE NEW U. S. PRACTICE SHIP CHESAPEAKE FOR THE NAVAL ACADEMY—FIRST (STEEL HULL) SHEATHED VESSEL BUILT IN UNITED STATES.

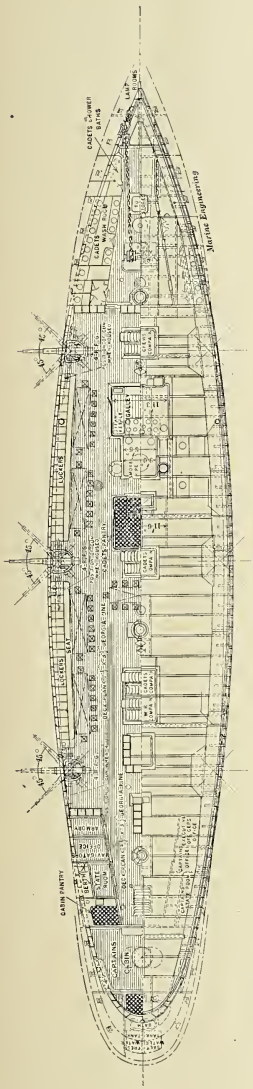


INBOARD PROFILE.

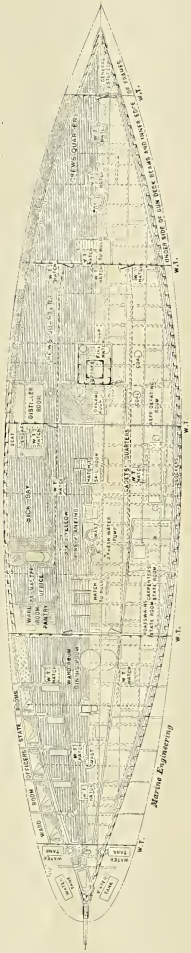


SPAR DECK.

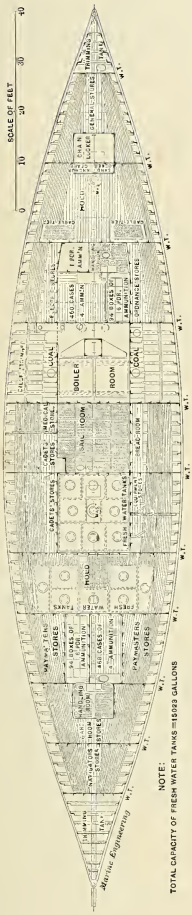
PLANS OF THE U. S. SHEATHED PRACTICE SAILING SHIP CHESAPEAKE, FOR NAVAL ACADEMY, BUILT BY THE BATH IRON WORKS, LTD., BATH, ME.



GUN DECK.



BERTH DECK.



NOTE:
TOTAL CAPACITY OF FRESH WATER TANKS 115193 GALLONS

HOLD AND MAGAZINE.

PLANS OF THE U. S. SHEATHED PRACTICE SAILING SHIP CHESAPEAKE, FOR NAVAL ACADEMY, BUILT BY THE BATH IRON WORKS, LTD., BATH, ME.

was developed as originally intended, and the contract for the construction of hull and fittings was awarded to the Bath Iron Works March 16, 1898. Additional funds were made available in February, 1898, the total appropriation being raised to the required amount of $250,000. The keel of the *Chesapeake* was laid August 2, 1898. She was launched June 20 of the present year, and on July 11 she left the yard of her builders and was handed over to the U. S. Government at the Boston Navy Yard. The spars, boats, outfit and furniture have been made at the Boston Yard.

Following are the dimensions and the most interesting particulars concerning the hull of the *Chesapeake:*

Length over all	223 ft. 6 in.
" L. W. L.	175 "
Beam, extreme	37 "
" molded	36 " 3 in.
Freeboard, ford	14 " 3 "
" aft	14 " 3 "
" amidship	11 " 3 "
Draft, mean	16 " 6 "
" aft	17 " 6 "
" ford	15 " 6 "
Displacement	1,190 tons
Area of midship section	378 sq. ft.
" " load water plane	4,570 " "
Tons per inch of immersion	10.86 tons
Meta-centric height	3.6 ft.
Range of stability	120 deg.
Max righting arm	2.5 ft.
" " moment	2,975 ft. tons
Angle of Max righting arm	58 deg.

The following general schedule of weights will also be of interest:

Hull and fittings	710 tons
Boilers, pumps, piping, etc.	45 "
Armament and ammunition	68 "
Equipment and outfit	223 "
Coal	22 "
Ballast	123 "
Total	1,190 "

The *Chesapeake* is a very lean vessel with high freeboard, and closed bulwarks throughout her length. She has considerable deadrise, the angle of her floors being 25 deg. with the horizontal base line. There are three continuous decks, two of which are plated with steel throughout. The steel construction of this vessel is very heavy, and she is sheathed with 4 in. Georgia pine in addition to having a steel bottom and sides fully equal in scantling to any steel gunboat of her size afloat. The transverse frames are spaced 24 in. apart. For 3-4 length amidship they are formed of Z bars 6 by 3 by 14 1-2 lb. per ft., split at the bottom of the bilge. At the ends of the vessel frames of angle bar 4 by 3 by 8 lb., with reverse frames 3 by 3 by 7 lb., run from the keel to the main rail in one piece. The floors are 43 in. deep in the center. They are made of 15 lb. plate of bracket construction. The vertical keel is 43 in. deep by 17 1-2 lb., with double angles 4 by 4 by 9 lb. on the top, and double angles 5 by 4 by 10 lb. on the bottom. The flat keel is 52 in. wide amidship and 30 lb. per sq. ft. The top of the vertical keel connects to a 30 in. by 17 1-2 lb. flat keelson plate, and the floors between the fore and aft longitudinal bulkhead are plated over with 12 1-2 lb. steel plate, forming a tank. The shell plating is of 15 lb. plate throughout, with the exception of the garboard and sheer strakes, which are of 17 1-2 lb. plate. The outside plating is doubled forward in wake of the chafe of the anchors. The upper or spar deck is plated over with 7 1-2 lb. steel plate, the stringers being 44 in. wide by 15 lb., connected to sheer strake by a 3 1-2 by 3 by 8 lb. angle bar. The gutter waterway is 9 in. wide, the inner angle up to which the plank is worked being 3 by 3 by 7 lb., and the outer angle which connects to the hammock berthing is 3 1-2 by 3 by 8 lb. The planking is of 3 1-2 by 3 1-2 first quality Georgia pine. The spar deck beams are 6 by 3 by 17 lb. angle bulbs located on every alternate frame; they have a camber of 8 in. in 37 ft. The hammock berthing extends on this deck for a distance of 136 ft. amidships. It is 4 ft. 4 in. high and 24 in. wide, the apertures on the upper inner side being 18 in. wide. The hammock berthing outside plating is of 12 1-2 lb. plate. The inner and top plate is of 10 lb. plate, and the divisions are made of 7 1-2 lb. plate, the angle bars being 2 1-2 by 2 1-2 by 5 lb. throughout. The middle deck—main deck—or gun deck, as it is called, has a 42 in. by 12 1-2 lb. stringer plate. The beams are 7 by 3 by 18 lb. angle bulbs located on alternate frames, with a camber of 5 in. in their midship length. The gun deck plank is 3 1-2 by 3 1-2 first quality Georgia pine. The lower or berth deck is plated throughout with 7 1-2 lb. plate, the stringer being 15 in. by 15 lb., connected to the ship's framing at side by 4 by 4 by 9 lb. angle bar, and to ship's plating by 3 by 3 by 7 lb. angle bar. The beams are of angle bulbs 6 by 3 by 17 lb., placed on alternate frames, the camber being 2 in. in 37 ft. The spar and gun deck beams have welded knees and the berth deck beams are connected to the framing by bracket knees. The wood keel of the *Chesapeake* is of East India teak, sided 16 in. and molded 26 in. It is well secured to the flat keel by composite screw bolts 1 3-8 in. dia., tapped into the steel plate with lock nuts on the inside. The false keel is of white oak 3 in. thick, worked in 12 ft. lengths and well fastened by composite spikes to the main keel. The outside planking extends from the keel to about 26 in. above the water line amidship, sheering up 15 in. forward and 12 in. aft. This planking is of 4 in. Georgia pine throughout, the upper edge being covered by an angle bar 3 by 3 by 7 lb. The plank is fastened to the steel shell by 3-4 in. brass screw bolts fitted with nuts on the inside. These bolts have a tensile strength of 42,500 lbs. The copper sheathing runs to a line 3 in. below the upper edge of the wood outside planking. The upper part of this surface is sheathed with 28 ounce copper, the bilge section is covered with 26 ounce copper, and the bottom is sheathed with 24 ounce copper.

Fore and aft w. t. wing bulkheads 62 ft. long are worked in the hold amidships. These bulkheads inclose the magazine forward, the boiler room, the sail room, and the fresh water tanks aft. In the wings are the electric stores, cadets' stores, medical stores and coal bunker on the port side, and the ordnance stores, bread-room, warrant officers' stores, equipment stores and coal bunker on the starboard side.

The boiler room is 16 ft. long and 14 ft. 6 in. wide. In it are located two steel Scotch boilers 8 ft. long and 6 ft. 6 in. dia., with single furnaces; a condenser with 150 sq. ft. of cooling surface; an air and circulating pump 4 1-2 by 5 by 6 by 6; a fire and bilge pump 10 1-2 by 6 1-2 by 10; feed pump 4 1-2 by 3 by 6, and a feed tank. The smoke pipe is 3 ft. outside dia., the height above the top of grate being 42 ft. There are 15 fresh water tanks in the hold. The average size of these in-

dependent tanks is 6 ft. by 4 ft. by 6 ft. The total capacity of these tanks is 15,030 gals. of fresh water. The after magazine is located aft of the tank spaces, the paymaster's stores being on each side of it in the wings.

The ward room stores and navigation stores are located aft, and the general stores and chain and sand locker are located forward. A trimming tank is located at each extremity of the vessel. On the forward berth deck is located a general storeroom. Then comes the crew's space, divided into two parts by a w. t. steel bulkhead, aft of which is the fire room hatch, dynamo room with 2 generators (the plant being in duplicate), distilling room and refrigerating room. The evaporator shell is 4 ft. dia. and 5 ft. 6 in. long over all, size 2-s-120. The distillers are 2-s-98. The evaporator feed pump 6 1-4 by 4 3-8 by 8, and the distiller circulating pump 3 by 2 1-2 by 4. In the refrigerating room a one ton Allen dense air ice machine is fitted.

On the port side of the berth deck amidships are located the dispensary, sick bay, with bathroom and w. c., paymaster's office and ward room pantry. On the starboard side the warrant officers' mess room, carpenters' and boatswain's rooms, and quarters for a few of the cadets. On the berth deck aft is the ward room, dining-room, ten staterooms and bathroom, complete in all respects. On the gun deck forward is the manger, with lamp room and small stores. Then comes the cadets' shower baths and dressing room, cadets' wash room, warrant officers' and ward room officers' w. c. on the port side, and the crew's w. c. and cadets' w. c. on the starboad side. A Hyde patent steam capstan windlass with wildcats for 1 1-2 in. chain is located between the wing w. c.'s. The cadets mess and swing their hammocks on the gun deck amidship. Here eight mess tables 12 ft. by 3 ft., with seats for fourteen at each table are carried. In the center of this deck are the galleys, pantries, etc., and aft are the executive officer's office, navigator's office, armory, captain's stateroom, cabin, bath, pantry and office. Six 4 in. r. f. g. are carried on the gun deck, three on each broadside, two forward, two amidships and two aft, each having 45 deg. angle of fire on each side of a line square with the center line of the ship.

The spar deck of the *Chesapeake* is a good clear deck fore and aft. A small monkey forecastle is worked forward, the space beneath it being used for the stowage of deck gear. Two 6 pdrs. are carried forward on the spar or weather deck, two are carried aft, and two 1 pdrs. are located amidship. A Hyde Robinson improved hand screw steering gear is located on the deck aft, the vessel having no steam steering gear. Seven boats are carried, viz.: a 30 ft. steam cutter, a 30 ft. launch, two 28 ft. cutters, a 28 ft. whale boat, a 28 ft. whale boat gig, and a 20 ft. dinghy.

The vessel has no chart or pilot house, but a large navigating bridge is located aft, just forward of the mizzen rigging. Pin rails, fife rails, topsail sheet bits, cavils, cleats, bits and fair leads, are located on deck to the best possible advantage.

The *Chesapeake* is a full rigged sailing ship, with three masts spreading 19,975 sq. ft. of sail all told; the area of the ten principal sails is 13,131 sq. ft. The fore truck is 130 ft. above the w. l., the main is 142 ft., and the mizzen is 115 ft. The following gives the lengths of the yards and fore and aft spars:

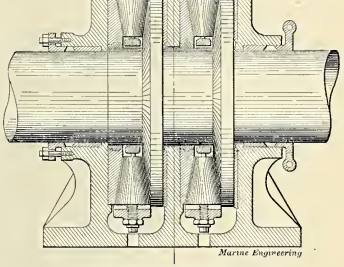
Fore lower yards	68 ft.
" topsail "	51 ft. 6 in.
" topgallant "	34 ft.
" royal "	24 ft. 3 in.
Main lower "	78 ft.
" topsail "	66 ft.
" topgallant "	45 ft. 9 in.
" royal "	33 ft.
Mizzen lower "	51 ft.
" topsail "	38 ft.
" topgallant "	25 ft.
" royal "	18 ft.
Fore spencer gaff	27 ft.
Main " "	27 ft.
Spanker gaff	35 ft. 6 in.
" boom	53 ft. 6 in.
Jib boom outboard	41 ft 3 in.

The center of effort of the sail is 8.33 ft. forward of the center of lateral resistance and 57.95 feet above the water line.

EXPERIMENTS ON THRUST BLOCK FRICTION—ROLLER BEARINGS AND PARALLEL BEARINGS.*

BY F. VON KODOLITSCH.

In the various text-books for marine engineers are to be found various data about the internal friction of marine engines, and we know approximately the proportion which exists between indicated horse power and brake horse power. But we know very little how much we lose in the thrust-block, tunnel bearings, and stern tube. To determine at least the amount of friction lost in the thrust-block, I have carried out a series of experiments to ascertain what percentage of the indicated horse power is lost by friction.



EXPERIMENTAL THRUST BLOCK.

Before I begin to describe how the experiments were carried out, I will give a description of the construction of the thrust-block itself.

As you can see by the engraving, this thrust-block is not of an ordinary design, but is a combination of a roller thrust-block for going ahead and an ordinary thrust-block with thrust collar and ring for going astern.

You will see that the distance from the center line of the thrust-block to the outside of the coupling is the

*Read before the Institution of Naval Architects, England.

same for each side; also the holding-down bolts are symmetrically placed in the center lines of the block. Moreover, there are in the two couplings no conical holes, but parallel ones, so that it is possible to use either the rollers for going ahead, and the white metal rings for going astern, or vice versa, by turning the shaft around. The object of this design is twofold. As this kind of thrust-block was a novelty to me, I wanted to secure by this design "a second string to my bow," so that in case the roller bearing should give trouble during the first voyage the whole bearing can be converted into an ordinary one by simply turning it around. The second consideration was produced by the intention to carry out the experiments which I am going to describe.

You will see by the engraving that on each side of the thrust-block is a sort of stuffing-box, and the whole block is cased in an oil-tight cast-iron box. This box is completely filled with oil to run the shaft in an oil bath. The experiments for ascertaining the friction produced with a full load on the block were carried out in the erecting shop. The dimensions of the marine engine to which this block belongs are as follows: 13 7-8 in high pressure, 22 1-4 in. intermediate pressure, 36 in. low pressure, by 24 in. stroke, and this engine develops 600 indicated horse power, at 136 revolutions per minute.

The ship travels at a speed of 12 knots. Applying now the formula for the indicated thrust, we find that to run the shaft in the shop under the same conditions as on board, it is necessary to place on top of the coupling a load of 11,047 lbs. As you will see, the shaft was placed in a vertical position in order to utilize the top surface of the coupling as a platform for applying the weights. On to the platform was fixed a small shaft of 2 1-2 in. dia., with a square head at the top of it. On this square head was applied a drill press with a pair of mitre wheels, of which the smaller pinion was driven by a universal joint attached to a telescopic shaft. At the further end of this shaft is again a universal ball joint, which is driven by an electric motor. By means of this arrangement it was possible to drive the thrust shaft at 136 revolutions with a load of 11,047 lbs., and I was able to determine how many horse power would be consumed by friction in actual running.

As you well know, an electric motor may be accurately indicated as a steam engine, if we place alongside of the electro-motor an amperemeter and a voltmeter. If we multiply the indicated amperes by the indicated volts, and divide by 736, we find the indicated electrical horse power.

But what we actually want is not the indicated electrical horse power, but how many foot-pounds were necessary for driving the loaded thrust-shaft at 136 revolutions. This would correspond to the brake horse power on the small shaft on top of the thrust shaft. The proportion between this brake horse power and the indicated electrical horse power is, of course, in this case, the efficiency of the driving apparatus. This was ascertained also by brake experiments independent of the thrust-block experiments.

A brake was applied at the end of the drill press and the number of amperes increased, and the brake correspondingly tightened up until the same conditions were obtained as in the case of the thrust-block experiments. The result of these experiments was that there existed an efficiency of 63 per cent between the indicated horse power and the brake horse power in the one case, and 67 per cent in the other case.

In the accompanying table are two columns, *A* and *B*. *A* shows the results obtained when rollers were used, and *B* the results when white metal rings replaced the rollers. The manner in which the experiments were carried out was so simple that it will require very little explanation. The first experiment, *A*, was made with rollers. The shaft was turned around at 136 revolutions with a load of 11,047 lbs., and the amperemeter showed 20.97 amperes and the voltmeter

RESULTS OF THRUST BLOCK EXPERIMENTS.

Revolutions per Minute.	Amperes.	Volts.	Indicated Electric Foot-Pounds.	Brake Foot-Pounds.	Efficiency of Motor and Gear.	Rollers A.	White Metal B.	Load.
						H.P.	H.P.	lbs.
136	20 97	100	2,097	1,321	63%	2.4		11,047
136	273.6	90	24,425	16,365	67%		29.75	11,047

100 volts; that means to say that we required 1,321 foot-pounds for turning the shaft. After this experiment the thrust-block with the shaft was turned round and fixed against the wall. The load was applied and the shaft again turned round at 136 revolutions.

The results are given in the second line of the table. In this case the efficiency of the motor and gearing was found to be 67 per cent.

To sum up the whole experiments, I found that in a marine engine of 600 horse power 136 revolutions and 12 knots speed of the ship, 29.75 horse power are lost in the thrust-block if of ordinary construction, and 2.4 horse power are lost if the thrust-block is made on the roller system.

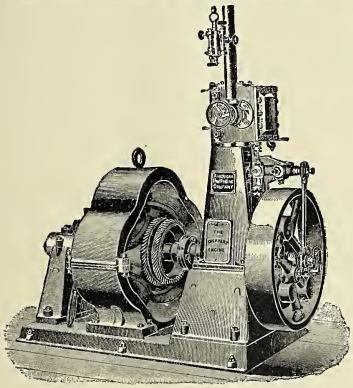
LARGE DRY DOCKS.—The largest dry dock in operation at the present time is located at Liverpool, and is known as the Canada Graving Dock. This dock, which was opened a few weeks ago, has the following dimensions: Length, 925 ft.; width at entrance, 94 ft.; depth over sill at high water, 32 ft. 6 in. The dock is equipped with three centrifugal pumps, which have a capacity of a little less than 1,000 tons a minute. With a vessel of 8,000 gross tons in dock these pumps emptied the dock in about 1 1-2 hours. The large dock at Southampton, Eng., known as the Prince of Wales Graving Dock, is of smaller dimensions, which are: Length, 750 ft.; width at entrance, 91 ft. 1 in.; depth over sill at high tide, 32 ft. 6 in. The new dock at Newport News, Va., will be about 900 ft. long.

U. S. S. KEARSARGE.—The battleship *Kearsarge* reached New York September 17 after having run the builders' preliminary trial, upon which she attained a maximum rate of speed of 17.25 knots. This was while her bottom was foul. In New York she was placed in the U. S. dry dock, and scraped and painted, before proceeding to Boston, from which port she will start out on her official trial.

IMPROVED APPARATUS.

Direct Connected Lighting Set.

In the accompanying illustration there is shown a marine lighting set consisting of an Onondaga dynamo coupled direct to a Shepherd vertical engine. The dynamo is designed with great care for the purpose intended. The armature—upon which so much depends for the successful working of a machine—is built up of discs made from the best grade of charcoal iron. The

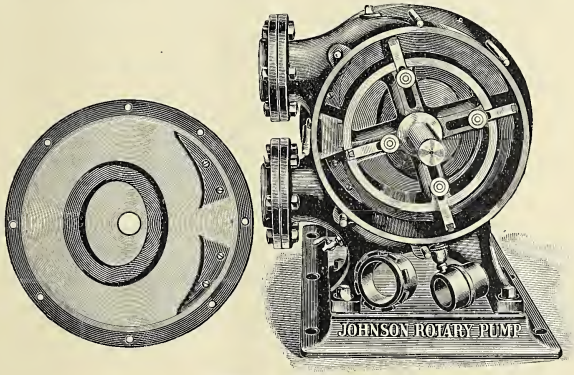


ONONDAGA DYNAMO, SHEPHERD ENGINE.

discs are brought together under heavy pressure, and are firmly held in place by heavy cast iron end plates, and slots are provided to receive the wire. The construction is such that when running a steady current of air enters the center of the core through the openings at each end, keeping the armature at an even temperature. The commutator is of generous proportions, and has a large brush contact surface made of the purest copper. The segments are mica-insulated, and the commutator is thoroughly ventilated. The shaft is of forged steel. Carbon brushes are used, and the brush-holder is designed to give a uniform bearing surface with light pressure. The load may change from zero to full load without causing any sparking and without shifting the brushes. The bearings are self-adjusting and self-oiling, machined with great accuracy. The engine used is the Shepherd type, described in a recent issue, and manufactured by the American Fire Engine Co., Seneca Falls, N. Y. The generator is manufactured and supplied by the Onondaga Dynamo Co., Syracuse, N. Y.

Johnson Rotary Pump.

In the illustration there is shown a compact form of pump known as the Johnson Rotary Pump, which in operation gives a continuous stream of water. It consists of an outside shell, with suitable parts for connecting suction and discharge pipes; two side plates with cam attached to each, and inside a circular spider or piston in which are held the piston heads which are operated by the cams. The piston does not bear at any point on the inside of the shell, so that there is no wear in this portion of the pump, which would in time allow the fluid to be carried from the inlet to the outlet. The separation between these orifices is provided by a butment which is fitted with a movable bronze shoe thrown forward by springs against the outer rim of the piston. In this way the wear is continually taken up and a tight joint maintained. Power can be applied by gears or pulleys secured to the shaft which is keyed to the piston, or this can be coupled direct to a vertical engine. The pump is made in a variety of sizes up to 6 in. dia. of suction and discharge pipes. A pump of this size occupies 27 in. by 50 in. floor space, and weighs 1,100 lbs. The speed of running is 125 revolutions per minute and the capacity at this rate is 750 gallons per minute. The pump is especially useful for wrecking, fire ballast or drainage uses. The maker states that it will pass dirt, coal dust, chips or any light obstruction without lessening its efficiency, and there are no valves to clog or derange. In cases where a long lift is needed a foot valve can be used. The pump is manufactured and marketed by the Davis Johnson Co., 41 West Randolph St., Chicago, Ill.



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MERCHANT shipbuilding the world over during the year 1898 is carefully classified and tabulated in the recent issue of Lloyds Register of British and Foreign Shipping, which organization has, of course, special facilities for the gathering of accurate data. An examination of these figures is always an interesting matter, and it is comforting this year to note that the United States has resumed second place in the quantity of tonnage put out. It will be remembered that when the totals for 1897 were footed up the second place was taken by Germany, that nation having turned out 81,107 tons more than the United States. For 1898, however, the figures give the United States a grand total of steam and sail of 169,196 tons, Germany coming after with a total of 136,186—33,010 tons less. This represented for Germany a decided falling off from the previous year in tonnage, though there was an increase of nine in the number of vessels built. In our case there were seventy-eight more vessels built in 1898 than in 1897, and the increase amounted to 96,615 tons. We have thus regained second place, which we held for the years 1895 and 1896, and from present indications there is little doubt but that this position will be retained when the totals for 1899 are secured. The figures used represent the gross register of steamers and net register of sailing vessels, and no account is taken of sailing vessels of less than 100 tons net register, or of steamers of less than 100 tons gross register. The United States total was made up of eighty-four steam vessels of 107,785 tons, and of fifty-six sailing vessels of 61,411 tons. Of these there were four vessels built on foreign orders; two small sailing vessels built for German owners and two steamers on Hawaiian orders—a total of 1,173 tons for the four. On the other hand American orders exceeding 3,000 tons were placed with British builders. Our steam tonnage for 1898 showed an increase over the preceding year of fifty-one vessels, and of 70,810 tons. In the case of sail tonnage the increase in number of vessels built was twenty-seven and in tonnage 25,805 tons. Of the total sail tonnage forty-nine vessels of 36,756 tons were built of wood and seven vessels of 24,655 tons were built of steel, all of the latter being over 2,000 tons net register. Our large sail tonnage includes vessels of the tow barge type, which by courtesy only can be called sailing vessels. These are being built in increasing numbers, especially for sea coast trade and are proving very remunerative. Coming now to the head of the list, this as customary was taken by the United Kingdom with 690 vessels of a total tonnage of 1,303,894; a very considerable increase over the figures for 1897 (907,611 tons), and a large gain also over the total for 1896. The grand total for the United Kingdom for last year was made up of 684 steamers of 1,301,325 tons and only six sailing vessels of 2,569 tons. Included in these figures are 142 vessels of 312,549 tons built in the United Kingdom on foreign orders; an advance over the previous year, when, however, the great engineers' strike had a considerable effect on the output. The proportion of the world's shipbuilding put out by the United Kingdom during 1898 was 72.78 per cent., an improvement also over the previous year, but still considerably under the maximum figures of former years. The year 1898 was a record breaker in shipbuilding, the total for all countries, 1,233 vessels of 1,791,485 tons, being the greatest of recent years, and only approached by the total for 1890, which was 1,362 vessels of 1,646,809 tons. France took fourth place last year with forty-one vessels of 53,483 tons, and Italy next with twenty vessels of 26,806 tons. Norway was sixth, and Japan seventh with 22,412 tons, an increase in her case of nearly 100 per cent. over the preceding year. There

was a very considerable falling off in the tonnage built by British colonies, the total for 1898 being forty-three vessels of 9,586 tons, and for 1897, forty-eight vessels of 14,932 tons. The average tonnage of all vessels built during 1898 was 1,452 tons, which is in line with the decrease apparent since 1895. Of the steam vessels built during the year eight exceeded 10,000 tons, fourteen were between 7,000 and 10,000 tons, and eighty-five were between 4,000 and 7,000 tons. A division of vessels built during 1898, according to material used, showed these totals: Composite, seven vessels of 1,686 tons; wood, 250 vessels of 79,193 tons; iron, ninety-one vessels of 15,344 tons, and steel, 885 vessels of 1,695,262 tons.

A VERY interesting summary of the progress in shipbuilding and marine engineering during the past sixty years was made by Sir W. H. White, chief instructor of the British navy, in a paper recently read before the mechanical science section of the British Association. The distinguished engineer chose for the title of his paper, "Steam Navigation at High Speeds." Sir William White is of opinion that the increase in size of steam vessels will continue, though progress in sea speeds will be necessarily slow, depending upon various considerations, which include lightness of structural material, use of special fuels, increase in steam pressures and rates of revolution, accompanied by an increase in the number of propellers employed. In the time specified the length of steamships had increased 40 per cent, displacement had trebled, and speed had increased one-half. Progress, he said, had been due chiefly to these changes: Growth in dimensions and weights of ships and in engine power; engineering improvements, making practical use of high pressures, with consequent economy in fuel consumption, and reduction in weight of propelling machinery in proportion to power developed; structural improvements in material used and general arrangement, giving relatively lighter vessels and larger carrying power; modifications of form leading to diminished resistance, and economy of power expended in propulsion.

"Speed has been increased from 8 1-2 to 22 1-2 knots; the time on the voyage has been reduced to about 38 per cent of what it was in 1840. Ships have been more than trebled in length, about doubled in breadth, and increased tenfold in displacement. The number of passengers carried by a steamship has been increased from 100 to nearly 2,000. The engine power has been made forty times as great. The ratio of horse-power to the weight driven has been increased fourfold. The rate of coal consumption (measured per horse-power per hour) is now only about one-third what it was in 1840. To drive 2,000 tons weight across the Atlantic at a speed of 8 1-2 knots, about 550 tons of coal were then burnt; now to drive 20,000 tons across at 22 knots, about 3,000 tons of coal are burnt. With the low pressure of steam and heavy slow-moving paddle-engines of 1840, each ton weight of machinery, boilers produced only about two-horse power for continuous working at sea. With the modern twin-screw engines and high steam pressure, each ton weight of propelling apparatus produces from six to seven horse power."

The author had a word to say about the introduction of the water-tube boiler on a large scale. Differences of opinion prevailed as to the particular type of water-tube boiler which might be adopted, but the "weight of opinion" was distinctly in favor of some type of water-tube boiler in association with the high steam pressures now in use. Greater safety, quicker steam raising, and, above all, economy in weight, accompanied the water-tube boiler; though as to economy it did not appear probable that with coal as fuel water-tube boilers would surpass the cylindrical boilers now in use, and "skilled stoking" was necessary to keep water-tube boilers on an equality with cylindrical boilers in the matter of coal consumption. Sir W. H. White at the same time called attention to the fact that as more perfect mechanical appliances are introduced so more skilled and disciplined management is required in order that the full benefits may be attained. In the engine room this had been appreciated and why not in the boiler room? Our opinion on this point is, that while it may be possible with the aid of naval discipline to get such results on war vessels it will be a much more difficult matter to introduce engine-room methods in merchant marine stokeholds. Working conditions are such in the average stokehold that the best class of labor is not attracted to the work. As the demand for high intelligence, rather than mere strength, becomes greater and greater, inventive genius will develop mechanical aids which will make the steam generating plant more exact and economical in operation. In the mechanical stoker now in embryo for marine uses will probably be found the solution. Liquid fuel would, as the author points out, solve the difficulty, but it is very doubtful if supplies sufficient for merchant use will ever be available. In materials of construction Sir William White sees possibilities for further progress, and he is of the belief that the shipbuilder will obtain substantial aid from the metallurgist in the future.

CORRESPONDENCE DEPARTMENT.

[Communications on matters of interest to marine engineers, for insertion in the correspondence department, are solicited. These, wherever possible, should be supplemented by rough sketches or drawings, which will be reproduced, if necessary to illustrate the subject, without cost to the writer.

Full names and addresses should be given, but publication of these will be withheld where requested.

We do not assume responsibility for the opinions expressed by correspondents.]

A Remarkable Newspaper Narrative.

Editor of Marine Engineering:

Noting the interest you take in mishaps to vessels, I send herewith a clipping from our local paper of a very remarkable breakdown at sea, which I believe will be of general interest:

"The steamship *Montucla*, of the Magellan Line, has just reached port, after experiencing a most remarkable and interesting series of casualties. The story, as we gather it from a cabin passenger, is substantially as follows:

"It appears that when in lat. 40 N., long. 86 W., one of the screw stay-bolts, which was occasionally used as a brake on the reversing engine, gave way without warning. This led to a collapse of the after horizontal tube-sheet of the donkey boiler, and at the same time allowed the reversing engine to run away with the air-pump links. In consequence of this combination of circumstances the vacuum escaped almost instantaneously into the high-pressure crank-pin brass. This caused the latter to swell with the increased tension, and suddenly brought the main engine to a standstill. Almost at the same instant the air-cock on the wing furnace of the starboard boiler became inflated, and in consequence partially filled up the spaces between the corrugations. Even the Mushet steel, of which the furnace crown was constructed, could not long stand the extra strain thus brought to bear, and with a deafening roar the furnace collapsed and drove the salinometer pot and three spare grate bars with terrific force through the thrust bearing, making a clean perforation from end to end. The steam thus liberated then found a vent into the sea through the runner of the circulating pump, and did no further damage.

"With commendable zeal the engineers set to work immediately to repair damages. A new screw-stay-bolt was first draw-filed up from a spare shaft-coupling, and after some difficulty was fitted in place. The collapsed furnace was then removed, and a spare section of funnel, which was fortunately at hand, was fitted in its place. At the same time the collapsed tube-sheet was cut out and retempered, while the bent and damaged flues were replaced by a few nickel steel condenser tubes. The furnace crown sheet was then secured in place by a rust joint. Having no rust convenient, however, an ingenious substitute was employed, composed of sulphur, ashes and iron filings, the latter being obtained by pulverizing one or two spare boiler zincs. The escaped vacuum was then forced out of the crank-pin brass by means of a 20-ton hydraulic jack, and the brass was thus reduced to its proper size. This freed the main engine, and it only remained to repair the thrust-bearing. After some consultation it was agreed to plug the hole with a patent boiler-tube-stopper, but after a few trials this was found ineffective, because the horseshoe rings were not prevented from jamming on the lignum-vitae of the stern bearing. Finally, however, the bearing pedestal was lashed in place by three turns of square sennit laid up from spare air-pump rods, and the hole was more effectively plugged by a phosphor bronze bolt sawn with a hack saw from a spare propeller hub.

"These repairs were completed in the surprisingly short time of 37 1-2 minutes, and proved in every way effective, the engines developing the surprisingly high duty of 107 I. H. P. per lb. of condensing water for the remainder of the trip.

"It is understood that the officials of the company propose to suitably reward the chief engineer and his assistants for the skill and resource which they manifested on this occasion." CHAPULTEPEC.

AMERICAN SOCIETY OF NAVAL ENGINEERS.—"We are in receipt of many inquiries as to to the propriety and prospects of retaining the individuality of the American Society of Naval Engineers," says the *Journal* of the society, "now that the Personnel Bill has removed the name of Engineer Corps from the Navy Lists. The inquiries are not unnatural, but imply a misunderstanding of the spirit of the Bill. The Naval Engineer not only exists in the American Navy to-day as distinctly as he ever did, but the whole tenor of the Personnel Bill is to expand the number of engineers by the addition of all the Line Officers. Eventually this must be the result, as essentially the modern naval officer must be an engineer. There is no diminution of interest in engineering by those who formerly were in the Engineer Corps, and there is no reason for imagining any waning of this interest. There is no profession which is advancing more rapidly, scientifically, than naval engineering. Its work approaches that of an exact science, in which generalities are replaced by positive facts and unimpeachable data. Continuous observation and study is the price of the retention of a position even in the rear ranks of the on marching body of the profession, and this society, with its name and purpose unchanged, will continue to hold a most important place in the engineering world."

S. S. INCHKEITH.—A new steamer, the *Inchkeith*, built on the East Coast of England for Liverpool owners, has been fitted with a set of Mudd's patent 5-crank, quadruple expansion engines, and the necessary equipments, the same as those originally fitted in the S.S. *Inchmona*, which, at the time, attracted widespread attention in the engineering world. It has been claimed for the *Inchmona* that the coal consumption during her entire period of service, since she was sent to sea in May, 1896, has not exceeded on the average more than 1.15 lbs. per indicated horse power per hour. The new steamship *Inchkeith* is of the following dimensions: Length, 348 ft.; beam, 47 ft., and depth, 28 ft. 1 in. On a draught of 22 ft. 5 in. her dead weight capacity is 5,600 tons. The vessel is of the spar deck type and has a total capacity for water ballast of 1,287 tons. The engines of the *Inchkeith* have cylinders, 17 in., 24 in., 34 in. and (2) 42 in. dia. with 42 in. stroke. The boilers, which are of the Scotch type built from Mudd designs, are calculated for a working pressure of 260 lbs. per sq. in., and are fitted to work with Ellis & Eaves induced draft. A very complete equipment of auxiliaries has been installed.

EDUCATIONAL DEPARTMENT.

HELPS FOR CANDIDATES FOR MARINE ENGINEERS' LICENSES—BOILERS.

BY DR. WILLIAM FREDERICK DURAND.

§ 2. MATERIALS AND CONSTRUCTION.

[1] Materials.

Open hearth mild steel[1] is used almost universally as the material for boiler construction, and in standard practice is used exclusively for shells, drums, heads, furnaces, combustion chambers and braces. Both steel and wrought iron are used for tubes, though solid drawn steel tubes may be considered as the better representing advanced engineering practice. Wrought iron is also used to some extent for rivets, though in the best modern practice steel rivets are preferred.

[2] Joints.

The various plates of a boiler are fastened together by riveted joints. These are of several varieties, as shown in the article on "Riveted Joints" published in the last issue of Marine Engineering, to which reference should be made.

The holes in the plates are either drilled or punched. The former method is much the better. In the operation of punching, a thin skin of metal about the hole is so severely strained that its strength, and especially its ductility and toughness, are reduced far below what they are in the remainder of the plate. This is not the case with the operation of drilling, or, at least, not to anything like the same extent. Drilled holes may also be located more accurately than punched holes, and thus with the former the parts of a riveted joint may be more perfectly fitted than with the latter. The operation of drilling leaves, however, a sharp edge, which should be removed by a reamer in order to avoid any tendency to cut the rivet. In spite of the greater cost of drilled holes they are now generally accepted as the best for all high-class work, and in many specifications no holes are allowed to be punched.

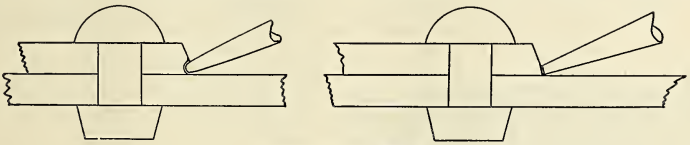
Riveting is either by hand or by machine; usually hydraulic. The latter gives much the better result, and is preferred where the machine can be made available. In many cases the construction is such that the jaws of the machine cannot be brought to bear on the joint, and in consequence hand riveting must be employed.

After being riveted the joints are calked to insure tightness against leakage. This operation consists in beating down the edges of the metal against the face of the opposite plate by means of special pneumatic driven or hand tools, as shown here in Fig. 1. These are known as *calking* tools, and are of two types, square and round nosed, as shown in the figures. The latter form is usually employed in modern practice.

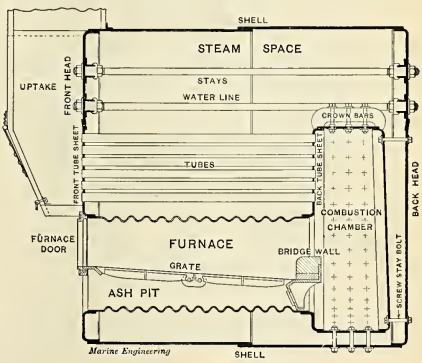
[3] Construction of Fire Tube Boilers.

We will now consider the chief features of the the construction of a Scotch boiler. This will, at the same time, sufficiently illustrate the operations involved in the construction of other types of fire-tube boilers.[2]

In the best practice the longitudinal joints are double butt-strapped and triple-riveted in order to give to the boiler in this direction the highest possible proportion of the strength of the plate itself. The circumferential joints, those which run around the shell, are lapped and double or triple riveted. So far as internal pressure is concerned the boiler is twice as strong to resist rupture around the girth as lengthwise, so that a lapped circumferential or girth joint is quite enough for strength alone, and it only remains to make it steam and water tight and to insure the necessary stiffness of the boiler as a whole. Single-ended boilers are usually made with two courses of plates, as in Fig. 2. Double-ended boilers are usually made with three courses. Each course consists of two or three sheets, varying with the diameter of the boiler. The heads are flanged, as shown in Fig. 2, and thus secured by riveting to the shell. In some cases the shell has been flanged instead of the head, but such form of construction is rare. The head flanges are sometimes turned out and sometimes in, as shown by the figure. Where machine riveting is to be used they must be turned



CALKING TOOLS.—Fig. 1.



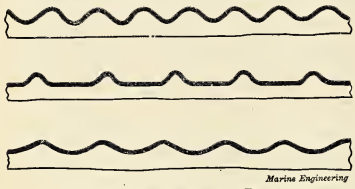
SCOTCH BOILER.—Fig. 2.

[1] See issues of April, 1899, page 44, and May, 1899, page 47.

[2] See July, 1899, issue, page 37.

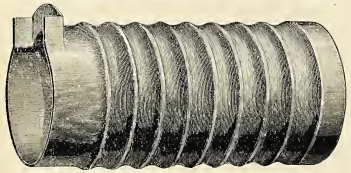
out in order to allow the riveter to do its work. The back head is made usually in two pieces, with double or triple-riveted lap joints. The front head is made in two or three pieces, according to size of boiler, usually with double-riveted lap joints. When in three parts they are called the upper head sheet, the front tube sheet and the front furnace sheet.

The furnaces, as shown, are corrugated in order to



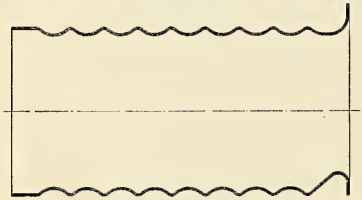
. FURNACE CORRUGATION.—FIG. 3.

give greater strength and elasticity. There are three styles of corrugation in common use, as shown in Fig. 3. The furnaces are riveted to flanges formed on the front furnace sheet, and are connected by flanging to the sheets of the combustion chamber. Several different modes of connection are in use for this purpose. In one the furnace end is left plain and the flange is all on the combustion chamber sheet, as in Fig. 2. In



FLANGED FURNACE.—FIG. 4.

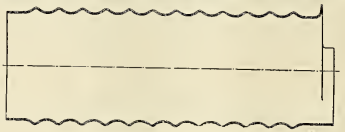
another the combustion chamber sheets are left plain and the flange is on the furnace, as shown in Fig. 4. In some forms provision is made for removal and renewal without disturbing the furnace head sheets. Thus, in Fig. 2, the diameter at the front is the same as or slightly larger than that at the outside of the corrugations, and so the furnace may be withdrawn



REMOVABLE FURNACE.—FIG. 5.

through the opening in the front sheet. In other forms of connection, where the furnace is flanged, especial provision must be made for removal, as shown in Fig. 5. Here the back end of the furnace is necked in on the bottom and sides, and a flange is thus obtained which only extends outside the outer diameter of the corrugation at the top. This flange serves to attach the furnace to the combustion chamber, and on cutting the joint loose the furnace may be taken straight to the front until the upper flange strikes the front sheet, and then swung upward and out of the front opening, as may be readily seen.

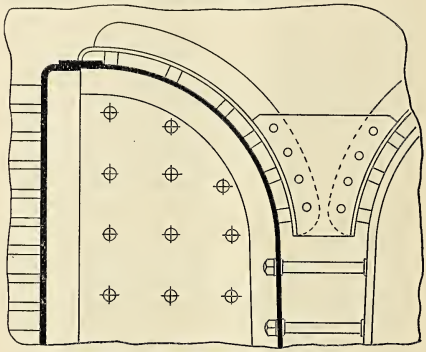
In some cases where it is difficult to obtain the necessary room on the front head for the greater diameter of the outside of the corrugation, or where, for other reasons, it is not considered preferable to have the furnaces removable without disturbing the front sheet, the furnace end at the front runs out on the smaller



NON-REMOVABLE FURNACE.—FIG. 6.

diameter, as shown in Fig. 6. Some one of the forms favoring easy removal may be recommended as preferable in all ordinary cases.

The combustion chamber, as shown, is built up of steel plates flanged and riveted together. The details of the construction vary somewhat with the form of furnace attachment adopted, with the size of the boiler, and with the choice of the designer. The front plate is known as the *back tube sheet*. The top of the combustion chamber is sometimes flat, as in Fig. 2, and sometimes rounded up, as in Fig. 7.



ROUNDED TOP COMBUSTION CHAMBER.—FIG. 7.

The tubes are secured into the tube sheets by "expanding," and "beading" or turning over at the back or at both the back and front ends. See Figs. 8, 9, 10. Tubes are expanded by means of a tool as shown in Fig. 11 representing the Dudgeon expander. The tool is introduced into the mouth of the tube and the small steel rolls are forced out by means of the tapering steel mandrel on which they rest. The mandrel is then turned around, and this by means of the frictional contact with the rolls causes them to turn also and thus to roll around on the inner surface of the tube, carrying the whole tool slowly round and round. The mandrel is continually forced in and thus the rolls are

forced outward against the tube. The action is thus a rolling of the tube out against the tube sheet, and in this way the joint is made thoroughly tight.

The Prosser expander which was generally employed in former years is now but rarely used. It consists, as shown in Fig. 12, of a hollow tapering plug divided up into separate elements or sections which are held together by a steel band. These are forced outward against the inner surface of the tube by driving a taper

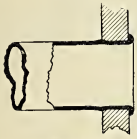


FIG. 8.

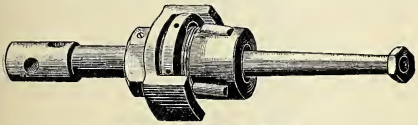
FIG. 10.

mandrel into the hollow between the elements. The action of the expander is thus to force the metal of the tube out against the edges of the sheet in a form of circular ridge as shown in Fig. 8.

Beading over the tube ends is usually done with a

FIRE-TUBE ENDS.—FIG. 9.

tool as shown in Fig. 13, and the result is as shown in Figs. 8, 9, 10. In some cases the tube sheet is recessed out for the beaded end of the tube, as shown in Fig. 10. The front ends of the tubes, as shown in Fig. 9, are usually swelled slightly larger than the rear ends to facilitate removal. The thickness of the metal of



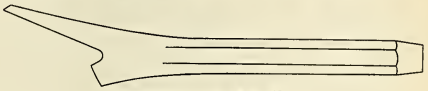
ROLLER EXPANDER.—FIG. 11.

plain boiler tubes is usually from 8 to 12 wire gauge, or from about .17 to .10 in.

In addition to the plain tubes fitted as before described, stay-tubes are also frequently fitted. These are of extra heavy metal, usually about 1-4 in. thick-

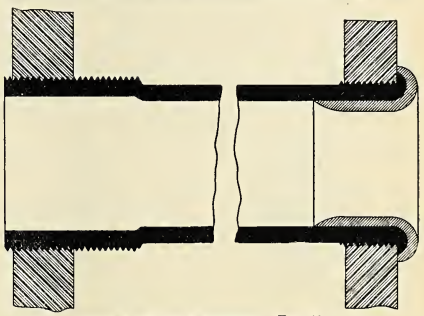
PROSSER EXPANDER.—FIG. 12.

ness, and specially fitted to the tube sheets by screw joints as shown in Fig. 14. These tubes act as stays between the tube sheets. Further reference to this point will be found under the head of *bracing*. When stay tubes are fitted, it is customary to bead over only the back ends of the plain tubes, as in Fig. 9. Not infrequently, however, no stay tubes are fitted, and in such case the plain tubes must be beaded over on both ends in order that they may securely support the tube sheets. Instead of the ordinary form of boiler tube, the *Serve* tube of cross-section as shown in Fig. 15 is frequently fitted. The ribs of metal reach down into the column of hot gas moving through the tube and



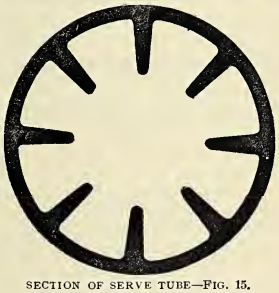
BEADING TOOL—FIG. 13.

furnish additional surface to absorb the heat and help it through into the water. The surface on the fire side is thus much greater than the surface on the water side,



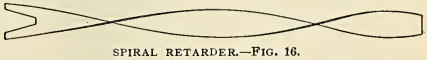
STAY TUBE WITH FERRULE.—FIG. 14.

while with the plain tube it is somewhat less. Such tubes usually show an increased evaporation per square foot of surface measured on the water side, of from 15



SECTION OF SERVE TUBE—FIG. 15.

to 20 per cent. Their increased weight, however, offsets in a measure this increase of evaporative efficiency per square foot of surface.



SPIRAL RETARDER.—FIG. 16.

Reference may also be made at this point to the use of *retarders* in boiler tubes. These are long twisted strips of thin sheet steel as shown in Fig. 16. They are simply laid in the tubes and serve to give the gases

more or less rotary motion and to assist in throwing them outward against the surface of the tube. With forced draft and high rates of combustion the use of retarders has been accompanied with a marked increase of economy. In some cases both Serve tubes and retarders have been fitted, but the special advantages of the combination may be called in question.

As a measure of protection for the back ends of tubes under forced draft, cast iron ferrules are sometimes fitted. Fig. 14 shows the so called *Admiralty* ferrule in place in a stay tube.

Bracing.—We must now consider the bracing needed to make the boiler perfectly secure and safe under the pressures to which the various parts will be subjected. The general principles to be kept in mind are as follows: (*a*) Cylindrical surface subjected to pressure on the concave side are not helped by bracing. They must be made sufficiently strong by giving to the material a suitable thickness. (*b*) Cylindrical surfaces subjected to pressure on the convex side may be stayed like a flat surface, or they may be stiffened by ribs running around them in planes at right angles to the axis. (*c*) Flat surfaces will support themselves if their area is sufficiently small in relation to their thickness and to the load per square inch, and it follows that large, flat surfaces must be subdivided into parts of such size that they may thus become self-supporting.

As an illustration of (*b*), furnaces were formerly strengthened in this way, and the long favorite Adamson ring as shown in Fig. 17 or the Bowling ring as shown in Fig. 18 may be taken as good illustrations of this mode of adding support to cylindrical surfaces loaded on the convex side. The present corrugated furnace, especially the Purves type as shown in Fig. 3, may be considered as a further illustration of the same principle. In modern marine boilers, aside from the furnaces, this mode of support is chiefly used to stiffen the bottom of single combustion chambers where screw stay bolts could not be readily fitted, and also in some cases the curved tops of combustion chambers. See Fig. 7.

Coming next to flat surfaces as referred to under (*c*) the necessary subdivision is provided by the fitting of braces connecting the part to be supported to some point where the support can be provided, or by connecting together two surfaces urged by the steam in opposite directions, as for example the two opposite heads of a boiler as shown in Fig. 2. Occasionally also flat surfaces are aided by attaching to them stiffening ribs of angle or tee bar, as on the front tube sheet between the nests of tubes, or between the tubes and the shell.

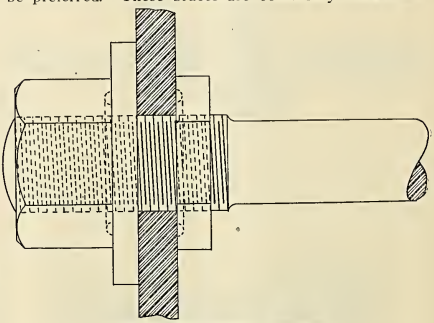
Plates which are subjected to the direct action of the fire, as in the furnaces and combustion chambers, are made relatively thin. This is done because a thin plate transmits heat better than a thick one, and is subjected to less severe internal stresses due to the difference in temperature of its two faces. The thinner the plate, however, the less the area which will be self supporting. Hence the braces for thin flat plates are relatively small and closely spaced, while those for thick plates are larger and spaced at a greater interval.

The main head braces are secured as shown in Fig. 19. A washer is fitted on the outside to increase the supported area, and a nut is fitted both inside and outside so that the joint may readily be made tight, and that the brace may, if needed, act as a strut against pressure from without as well as a tie against pressure from within. In some cases a relatively thin plate is supported by a brace connecting it to a thicker or perhaps to a doubled plate, or to a place not requiring support itself, but which furnishes a convenient point for carrying the load. In such case the attachment to

ADAMSON RING.—FIG. 17. BOWLING RING.—FIG. 18.

the thin plate is often made as shown in Fig. 20 in order the better to subdivide and distribute the support. In double ended boilers, certain parts of the head, as for example those between the furnaces, are supported by braces running obliquely back to the shell and attached as shown in Fig. 21. It often thus happens that braces must run at a slight obliquity in order to connect the parts to be supported with convenient points of support. Other instances are often found in the braces connecting parts of the back tube sheet below or between the tubes to the boiler head. In all such cases, wedge shaped washers as shown in Fig. 22 must be fitted under the nuts in order to get a good bearing between the nut and the shell.

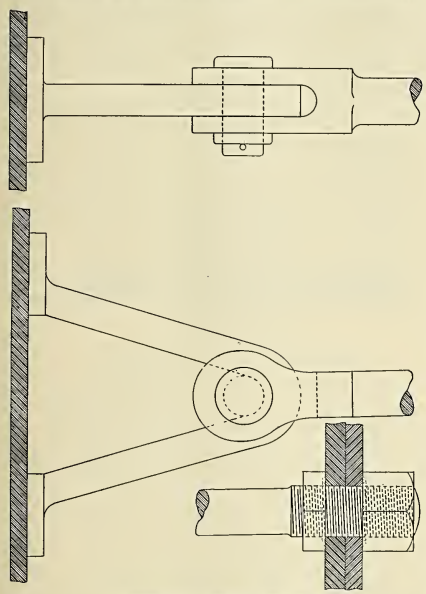
The braces connecting the relatively thin plates of the combustion chamber to the back head and shell of the boiler and to each other, are fitted by screwing them through into both plates as shown in Fig. 23. The ends are sometimes riveted over and sometimes fitted with nuts. In some cases they are left threaded the entire length, in others the threads are raised on the ends, as in the main head braces. The latter practice is much to be preferred. These braces are commonly known as



MAIN HEAD BRACE END.—FIG. 19.

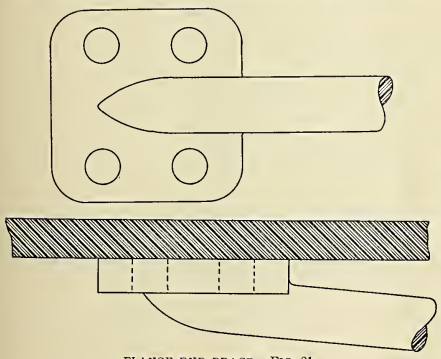
"screw stays," or "screw stay bolts." This mode of fitting enables the screw stay bolt to act both as strut and as tie, or to resist pressure in both directions. In some cases the older form of "socket bolt," as illustrated in Fig. 25, is still fitted. In such case the head is riveted and the part of the bolt between the plates is provided with a hollow "socket." This acts as a strut and as a

protection to the bolt proper. In modern approved practice screw stay bolts are either hollow or are drilled in at each end, see Fig. 25, to a point well beyond the inner face of the supported plate. The expansion and



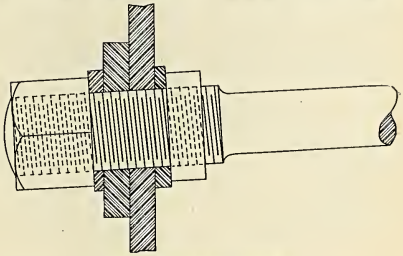
FORKED END BRACE.—FIG. 20.

contraction of such parts of the boiler often have the effect of bending these bolts back and forth, and they may thus in time become broken off, the break naturally occurring near the thicker of the two sheets where



FLANGE END BRACE.—FIG. 21.

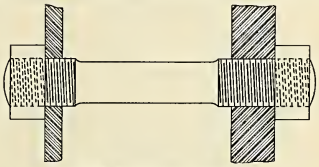
the bolt is held more rigidly. If this should occur, or if the bolt should become badly corroded or pitted, especially near the plate, warning will be given of the fact by the escape of water or steam, and proper means may be taken for replacing the bolt. In this way timely warning may be given of a condition of affairs, which if allowed to go unnoted, might result in



OBLIQUE BRACE END.—FIG. 22.

a collapse of the plate, or in a disastrous explosion of the boiler as a whole.

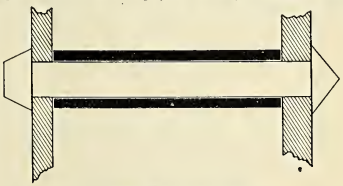
For the support of the top of the combustion chamber, girders or cross-bars are used, see Fig. 26. The load is transferred by means of the bolts from the com-



SCREW STAY BOLT.—FIG. 23.

bustion chamber plate to the girder, while the latter is supported by the edges of the vertical plates forming the front and back of the chamber.

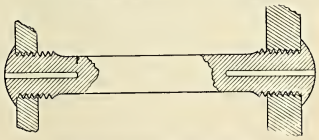
These girders are made of two pieces of steel plate, usually from 1-2 in. to 3-4 in. thick, bolted or riveted



SOCKET BOLT.—FIG. 24.

together with distance pieces between so that the bolts which take the load from the flat plate may pass up between them as shown in the figure.

The combustion chamber is sometimes secured to

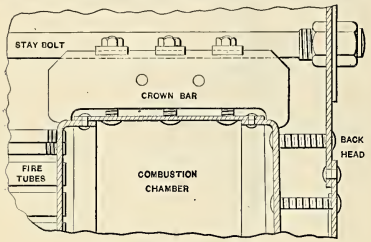


IMPROVED SCREW STAY.—FIG. 25.

the back head of the boiler, or in double ended boilers the two combustion chambers are secured together by

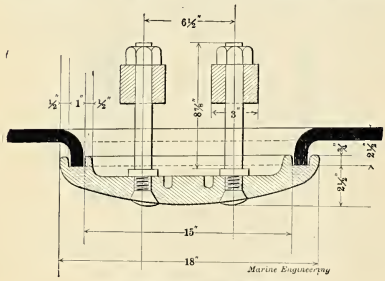
plate braces fitted as shown in Fig. 7. Such are usually called *gusset* braces.

In the general internal arrangement of the tubes, furnaces and combustion chambers, care must be taken to



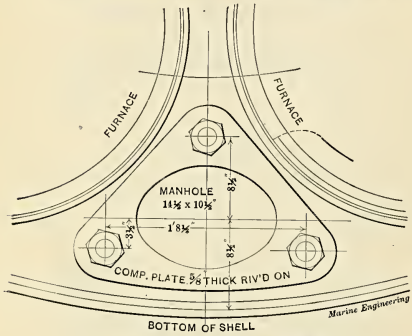
CROWN BAR.—FIG. 26.

allow, as far as possible, a ready examination of the various parts. In good modern practice a space of



FLANGED MANHOLE.—FIG. 27.

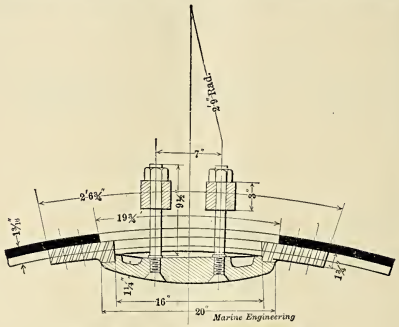
from 10 to 12 inches is left between the nests of tubes and between the tubes and shell, so as to allow the pas-



MANHOLE BELOW FURNACES.—FIG. 28.

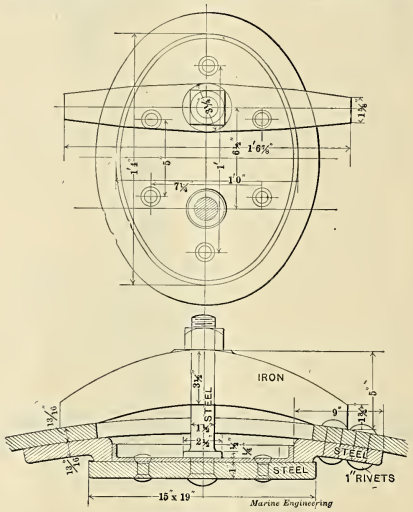
sage of a man from the steam space down through these spaces to the furnaces.

Manholes and Covers.— For the purpose of entering, examining and cleaning the interior of a boiler, man or hand holes are cut in the head or shell. These are then covered by *manhole covers*, *plates* or *doors*, as they are variously called. These are secured by bolts and dogs, as shown in Figs. 27-30. The usual size of a manhole is 11 by 15 inches, which are the dimensions required by the U. S. rules. It is of oval or elliptical



CAST STEEL RING AND DOOR.—FIG. 29.

shape, so that the cover with its lip extending over the edge may be gotten in and out without difficulty. The joint is made on the inside in order that the pressure may tend to keep the joint tight. A hand-hole is entirely similar in shape and fitting, and is simply smaller in size. In order to provide local strength and stiff-



MANHOLE DETAILS.—FIG. 30.

ness and to help support the load which comes on the feet of the dog, and also when the hole is cut in the shell to restore in some measure the metal taken out, a reinforce ring of metal is fitted about the hole. Such a ring of cast steel for a hole in the shell is shown in

Fig. 29. The inner face is plane, so that the joint with the cover is readily made. In order that the removal of the metal may affect as little as possible the strength of the shell, the longer axis of the hole should run around the boiler rather than lengthwise. For holes in the head of a boiler the metal is often flanged inward as shown in Fig. 27, the joint being made against the dressed edge of the ring. Where a manhole or handhole comes close to the through braces, as, for example, below the furnaces, the reinforce plate is cut in a shape approximating a triangle, as shown in Fig. 28. At each angle or corner the plate is of sufficient width to let the threaded end of the brace come through, and the outside nut is then jammed down on the ring. For heavy pressure the fitting illustrated in Fig. 30 may be recommended. The reinforce ring is of flanged steel, and the cover of steel plate also, somewhat thicker than the metal of the shell. An angle iron, as shown, is riveted to the cover, making a neat fit within the reinforce ring, and keeping the plate accurately to its seat.

QUERIES AND ANSWERS.

(Communications intended for this department will not receive attention unless accompanied by the full name and address of the sender, which will be considered confidential.)

Q.—What is meant by the statement about an engine that "she will run on 20 lbs. of steam per horse power per hour," and how is this determined?

OAKLAND.

A.—One horse-power means the doing of 33,000 foot pounds of work in one minute. This means the work required to raise 33,000 pounds, 1 foot high, or 1 pound 33,000 feet, or 33 pounds 1,000 feet, or 100 pounds 330 feet, or any other combination of weight and distance, which will make 33,000 by their product, or more generally, any combination of a force overcome through a certain distance such that the product of the force measured in pounds multiplied by the distance measured in feet shall be 33,000. Now, if an engine performs this amount of work every minute for one hour it is said to give one horse-power per hour, or one horse-power hour of work. Similarly if an engine develops 200 horse-power for one hour, it does 200 horse-power hours of work.

Now the engine, in order to do this work, has to be furnished with steam or rather with the heat which the steam carries. We must remember that it is the heat which the engine really uses, and the water or steam is only a carrier for it.

The steam used per horse-power per hour or per horse-power hour means then simply the total steam which the engine requires per hour, divided by the horse-power developed, or the steam which each horse-power may be supposed to take.

For good triple expansion condensing marine engines, this will be not far from 15 pounds. For compound-condensing engines 18 to 20 pounds will be a fair figure. For single condensing engines the amount will rise to 25 pounds or over, while for simple non-condensing engines the amount required will be from 30 to 40 pounds or over.

The determination of this amount requires a regular engine and boiler test, in which the amount of feed water required is measured for a considerable period of time, say 8 or 10 hours, while at the same time the power developed is determined from indicator cards taken at frequent intervals, say every 15 to 30 minutes throughout the period of test.

Q.—In fitting out a new steamer I have decided to place a generating set on an artificial foundation to get rid of the unpleasant vibrations which the generating set when running usually sets up in a vessel. The set is a direct connected one and will be placed on the middle platform. The intention is to place the machine on a pedestal 24 in. high of 1-4 in. plate and to fill this with a grout of gravel and cement. In this case the extra weight is not a consideration. What is your idea of the matter? W. L.

A.—The effect of this style of foundation on ship vibration is a matter difficult to predict in an abstract case. The vibrations depend on the unbalanced forces developed, on the location of the machine and the strength of the ships in its neighborhood, and on the relation between the revolutions of the dynamo and the natural period of vibration of the structure of the ship on which the machine rests.

The effect of a grouted foundation will be two-fold: 1. It will absorb in slight degree the vibratory influences, less as the foundation is more solid and rigid, and more as it is less firmly bound together.

2. Due to its own weight it will considerably increase the natural period of vibration of the platform, and thus possibly remove it from the likelihood of sympathetic vibration in step with the dynamo.

It may result from these effects that the vibrations will be considerably less than if the machine were placed directly on the floor plates, but if such should be the case it would seem more likely to be due to the latter rather than to the former of the effects noted above. It does not seem likely that merely as a damper or absorber of vibratory influences a grout foundation such as you refer to would be of much avail.

Q.—Which will travel the faster, and why, a ship being towed by a tow-boat, or the same ship fitted up with the same power that is in the tow-boat?

C. L. N.

A.—The ship alone will travel faster than the tughoat with the ship. The reason for this may be seen by working out an example.

Suppose that the tug's engine develops 1,000 I. H. P. Now, due to the necessities of tughoat design, the propeller is necessarily rather small to absorb this power at the ordinary towing speed, except at a high value of the slip. That is, when towing at an ordinary speed of say 8 miles, the slip of the propeller is large, perhaps 40 or 45 per cent or more. This is so well known that no further consideration of the point is necessary. As a consequence the propeller efficiency will be rather poor, and the *effective horse power* (what is left after taking away the loss by friction in the engines and the loss by the propeller) will be probably not more than about 450 H. P. This is the power, in other words, which is directly used in pushing the tug and pulling the ship. We will suppose that 1-5 of it goes for the tug and 4-5 for the ship. Then the latter amount is 360 H. P., and this we remember is the actual net amount required to pull the ship at a speed of 8 miles.

If, now, the machinery were fitted directly to the ship, the propeller could be better designed for its work, and its efficiency would be correspondingly higher. We may fairly assume in such case that the effective horse power would be say 55 per cent of the I. H. P. This means that the necessary I. H. P. to give 360 E. H. P. will be 360 ÷ .55, or about 650.

It thus appears that 650 I. H. P. properly fitted in the ship will give a speed of 8 miles, while, 1,000 I. H. P. are required for the same speed when the ship is towed by the tug. With the 1,000 I. H. P. applied in the ship with the same efficiency the speed would be raised to about 9 1-4 miles.

The gain is thus seen to be twofold:

(1) A gain due to the fact that with the ship alone there is less to be moved and less resistance to be overcome than with the ship and tug together.

(2) A gain due to the better efficiency which may usually be expected from the machinery fitted in the ship than in the tug at the towing speed.

The figures taken above are intended, of course, to illustrate a single supposed case, and while actually the gain might be greater or less than in the case taken, the principles would remain the same.

It is reported that the American liner *Paris* sustained severe structural damage by stranding on the Manacle Rocks.

ENGINEERS' DICTIONARY.—XX.

Governor—A device for controlling the revolutions of a steam engine and preventing racing when the propeller is partially lifted out of the water by the pitching of the ship. The early types of marine engine were usually governed by hand at the throttle, which was commonly of the "butterfly" variety, though occasionally automatic means of moving the valve were employed. With modern multiple expansion engines it is impossible to satisfactorily control the revolutions by the throttle. With such engines the control must come from the slide valve gear, the links of which may be linked up more or less as required when the propeller is uncovered, and linked out again as it is submerged. Where no automatic governor is fitted, this must be done by hand control of the reversing gear. The modern automatic governor is intended to take the place of this hand control.

There are two modes of actuating marine governors. (1) By utilizing the varying pressure under the stern of the ship. (2) By utilizing a variation in the revolutions from the regular speed. In the first type a pipe is run from the outside water at the stern to some form of pressure chamber near the engine, within which is a flexible diaphragm held in position by a spring or other equivalent means. The water being admitted to this pipe, the air within is compressed according to the head of water over the outer end. The apparatus is so adjusted that at normal draft the diaphragm is in equilibrium between the two forces, due to the water pressure on one side and the spring on the other. A change in the depth of water will cause a variation in the pressure which will be transmitted through the air and thus destroy the equilibrium, throwing the diaphragm in one direction or the other. This may be made to actuate a steam valve and thus through an auxiliary steam piston control the reversing lever and thence the links. In former times this type of gear was sometimes made sufficiently large to actuate the steam throttle valve directly, or sometimes a like valve in the exhaust pipe.

The other type of governor is found in various forms. In many of them use is made of the centrifugal force of revolving balls or weights somewhat as in the ordinary stationary governor. Through the force thus available a small valve is operated, thus leading through a series of stops to the control of the reverse lever or other part which it is desired to operate. Again in other forms a revolving fan or propeller working in a box filled with liquid maintains the apparatus in a certain condition at a certain speed. With a sudden change of speed, a corresponding change of resistance to the motion is met with, and this difference of force may be used to operate a small valve, and then, as before through the proper steps, the reversing lever is controlled. In another form a pump continually forces air into a chamber from which it escapes through a cock whose opening may be regulated at will. For a given size of outlet and speed of pump the pressure will rise until finally as much escapes as enters and the pressure remains constant. If the speed changes, however, the pressure will change correspondingly, and this difference of pressure will give a force which may be used as already explained.

All forms of marine governor are somewhat slow in controlling the variations of speed. The ideal governor would anticipate the motion and close down or open up just in advance of the rise or fall of the stern. Instead of this it opens and closes only after the stern has risen or fallen, and after the variation of speed has become more or less pronounced. It is usually considered good practice, however, to fit some form of automatic governor, at least as an emergency control, so as to prevent an excessive increase of revolutions from any cause whatever, as, for example, the breaking of the shaft or other like accident. For this reason those forms of governor which depend on a change of speed are to be preferred, and are usually fitted in modern practice.

Graphite—One of the forms of carbon. It is the substance commonly called *black-lead*. It is much used in modern engineering practice as a lubricant, either alone or in combination with a heavy oil. It is also used with oil or grease in the form of a putty for making up screwed and faced steam joints, and for coating sheet packing used in making bonnet and cover joints of various kinds. It is also used as a constituent of many forms of fibrous packing, both for steam and water joints, and for stuffing-boxes.

Grate—That part of a furnace on which the burning fuel is supported. The grate is formed of grate bars of various forms with spaces in and between them, the whole forming a support through which the air may enter and pass upward through the fuel, and through which also the ashes may fall to the ash-pit below. The area of the air passages through the grate is usually about one-half of the grate surface, though this as well as various other features of the grate depend on the nature of the fuel to be burned.

Grate Bars—The bars which compose a *grate*. They are of two general types, *stationary* and *shaking*. In Fig. 79 is shown a cut of an ordinary cast iron stationary grate bar. Shaking grates or shaking grate

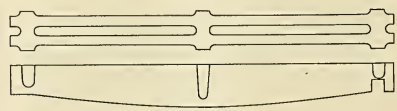


Fig. 79.

bars are found in a great variety of forms, the general purpose of all being the provision of means whereby the shaking of the grate will break up the fire, rattle out the ash and clinker, and give the air free access to the burning coal.

Grate-Surface—The surface or area of the grate. This is one of the fundamental characteristics of a boiler, for together with the rate of combustion per square foot of grate it determines the total amount of coal which can be burned.

Guard—A general term relating to some portion of a machine or appliance intended to guard or protect some other portion, or to control or limit its motion. See for example the air-pump-valve-guard under *Air pump*, Fig. 2.

NEW PUBLICATIONS.

THEORETICAL NAVAL ARCHITECTURE. A text book by E. L. Attwood, Assistant Constructor Royal Navy. First Edition 1899. Longmans, Green & Co., London and New York. Size 5 by 7 1-2. Pages 292. With 114 diagrams, cloth, $2.50.

According to the author's preface this book has been prepared in order to provide students and draughtsmen engaged in Shipbuilders' and Naval Architects' drawing offices with a text book which should explain the calculations which continually have to be performed. It is intended also that the work, and more especially its later portions, shall serve as a text book for the theoretical portion of the examinations of the British Science and Art Department in Naval Architecture.

The book is written throughout in a simple and elementary style, and the subject matter proper seems to be well selected, and the demonstrations are given in plain and simple language.

In the development of the subject the author has avoided the use of the calculus, and as a necessary consequence has seriously handicapped himself in its presentation, and in the proof of many of the most familiar operations. To some extent this lack is made up by an appendix, where a few of the omitted proofs are given in more general form by the aid of the higher mathematics.

It is perhaps to be regretted that the author felt compelled to include with his proper subject matter a certain amount of elementary geometry, trigonometry, and mechanics. In a text book on Naval Architecture the policy of devoting space to matter of this character may be questioned.

A special feature of the book is found in the examples given in connection with the various chapters. Many of these are drawn from actual office practice, and should be of especial value to those working by themselves.

The field covered by the subject matter, as a whole includes the operations and problems usually arising in statical naval architecture, with short chapters on the strength of a ship and on resistance and power. These latter chapters are the least satisfactory in the book. They are too incomplete and fragmentary to be of real value to the student of the subject, either from the theoretical or practical point of view. All reference to propulsion and to the propeller is omitted.

From the standpoint taken by the author and with the limitations under which he has chosen to work, the earlier chapters especially seem to furnish an excellent presentation of the subject. The task is a difficult one of dealing with such a subject in which the actual mental attitude must necessarily be one involving the conceptions of higher mathematics, but without using their nomenclature or methods of analysis.

The book should be of great aid to those not familiar with higher mathematics, and who wish to study the elementary theory of ship computations, but in the minds of all true students it must necessarily leave a desire for the greater fulness of treatment and generality of explanation which can only be provided by the aid of advanced mathematics. Such is doubtless the expectation and hope of the author, and under his self imposed limitations he has succeeded in providing an extremely interesting and valuable work for those interested in the subject.

A PRACTICAL COURSE IN MECHANICAL DRAWING. By William Fox, M.E., and Charles W. Thomas, M.E. First Edition, 1899. D. Van Nostrand Co., 23 Murray St., New York. Size, 5 by 8 1-2. Pages 98, with numerous illustrations. Cloth, $1.25.

According to the authors, both of whom are members of the faculty of the College of the City of New York, the object of this work is to provide a simple, practical course of progressive lessons in mechanical drawing, particularly adapted to the needs of high schools, schools of apprentices and young mechanics. The subject is a difficult one to present, and it is to be doubted if justice can be done to it in a volume of this size. The book proper consists of 32 exercises, several of which are devoted to the proper uses and handling of drawing instruments, and the remainder to concrete examples instead of an abstract and general presentation of the subject. With one or two exceptions these exercises are unusually good and make the book, as a whole, rather better than the average presentation of the subject. The book is, however, open to criticism in several particulars. The introduction seems to be rather beyond the average beginner, and the method of explaining the elementary principles of projection drawing (that of placing the object within a glass box and tracing on its panes the views of different faces) seems scarcely adequate. The proper relative positions of the different views of an object, according to the principles of projection, could have been given more prominence and explained more fully, since neglect in this particular, in practice, frequently leads to expensive "shop mistakes." Among other things which could well have been more extensively treated is the subject of drawing to scale. This is often one of the most difficult points for a beginner to master. The chapter on lettering might lead to artistic effects, but is not to be commended from a work-a-day standpoint. With two exceptions the examples of freehand lettering given are amateurish, and would not be passed in any draughting room where lettering is employed to convey instructions and not to produce a pleasing "picture." This is a common fault with books of this class and with young draughtsmen; it impairs the commercial value of both. The same criticism applies to the drawings throughout the book, few of which are even passably good, and nearly all are reduced to so small a scale as to be difficult to read. An excellent feature, however, is the fine half tone reproductions of photographs showing how various instruments should be held when in use.

Recent Publications.

There are many persons engaged in marine work who would like to have a good working knowledge of guns and their mounts and fittings, and of projectiles such as are used in modern naval practice; and yet these persons have neither time nor inclination to undertake a study of the subject as set out in text books and scientific treatises. It is for the information of such, primarily, that the book entitled "Naval Gunnery" was written by Captain H. Garbett of the British Navy. A sub title gives the explanation that the work is a description and history of the fighting equipment of a man-of-war, and it is dedicated by the author "to the

largely increasing members of the General Public who are interesting themselves in naval matters." On this side of the Atlantic the number of this class has increased very greatly since the breaking out of the late war. As the book is not intended for experts, it is written in a pleasant, discursive style, and yet in no place is it trivial. It is free from abstruse technicalities and mathematical demonstrations, so that the reader can go right ahead and absorb exact information with the minimum of mental effort. The history of the heavy cannon is written, from the smooth bore muzzle loading 68-pounder down to the modern naval weapon of over 100 tons, and in smaller guns from the 32 pounder to the 6 in. rapid firer of to-day. The chapters relating to modern weapons describe British practice chiefly, and while the special types of other nations are not exploited the reader will obtain a sound elementary knowledge of the principles involved. Naval guns everywhere are built with the same object in view—the maximum of destructive capability with the minimum of weight, bulk and expense, and a general knowledge of the subject can readily be supplemented by a special knowledge of the practice of our own or any other nation obtained from other sources. Some of the details treated in different chapters are: Breech loading rifles; rapid fire guns; magazines and loading arrangements; sights and firing arrangements; powder and high explosives; projectiles and fuses. To these are added chapters on the development of the modern battleship and its fighting organization. There are many fine engravings and drawings illustrating the text, and the book is of convenient size, and is printed in excellent style. It is one of the "Royal Navy Handbooks," published by George Bell Son's of London, and is sold in the United States by The Macmillan Co., 66 5th avenue, New York. The price is $1.50, cloth bound.

S. S. WINIFREDIAN.—The new steamer for the Liverpool-Boston route of the Leyland Line has been named the *Winifredian* and has been completed by Harland & Wolff at Belfast. This vessel is one of the modern type of steamships, with moderate speed, limited passenger accommodation, and large cargo carrying capacity. Her dimensions are: Length, 552 ft.; beam, 59 ft.; depth, 41 ft. Her dead weight carrying capacity is about 13,000 tons and load displacement about 20,000 tons. She is fitted with triple expansion engines, with cylinders 38 in., 56 in. and 94 in. dia. by 66 in. stroke, and of about 6,000 indicated horse power. She is a single screw vessel and has a sea speed of about 14 knots. Steam is generated in cylindrical fire-tube boilers, built for a pressure of 200 lbs. She has bunker capacity for about 1,100 tons of coal.

The new Allen Line steamer *Bavarian* for the North American trade ran its official trial trip on the Clyde recently, and a mean speed of 17.95 knots was attained. The new vessel is of the following dimensions: Length, 520 ft.; beam, 59 ft.; depth 43 ft., and gross tonnage, 10,200 tons. She will have accommodation for 500 passengers of all classes.

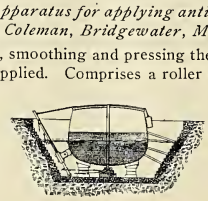
The former Guion liner *Alaska*, described in our issue of August, 1899, has been resold to Vickers, Sons & Maxim, engineers and shipbuilders at Barrow, for $95,000. She is reported to have been put to use as a floating hotel for workmen.

SELECTED PATENTS.

(Subscribers are notified that the publication of a patent specification in this column does not indicate editorial commendation or condemnation.)

631,154. Apparatus for applying anti-fouling coatings. G. D. Coleman, Bridgewater, Mass:

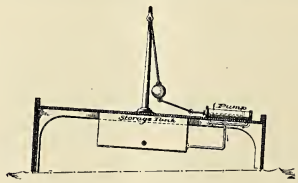
For rolling, smoothing and pressing the coating after it has been applied. Comprises a roller having a piv-



oted support, a traveling carriage on which the support is pivoted, and a guiding framework for the carriage.

631,178. Apparatus for utilizing wave-power. Thomas Redding, Seattle, Wash.

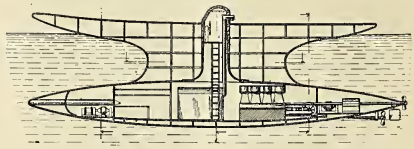
A standard rises from the deck of the vessel and a weighted pendulum is suspended from this standard and connected with an air-pump. The air-pump is se-



cured to the deck of the vessel and communicates with a storage tank. The motion of the vessel causes the pendulum to swing and thereby operate the air-pump. The air is forced into the storage tank, from which the compressed air may be utilized to drive machinery on the vessel or for other purposes.

631,417. Torpedo Boat. C. L. Burger, New York, N. Y.

Secures the advantages of both the surface and submarine torpedo-boat by employing a submarine hull carrying the guns, machinery, etc., and an upper cellular



hull filled with cork or similar substance so as to be unsinkable. The two hulls are connected by a small hollow web, and an armored air-shaft and conning-tower rises through the said web to form a means of communication between the two hulls.